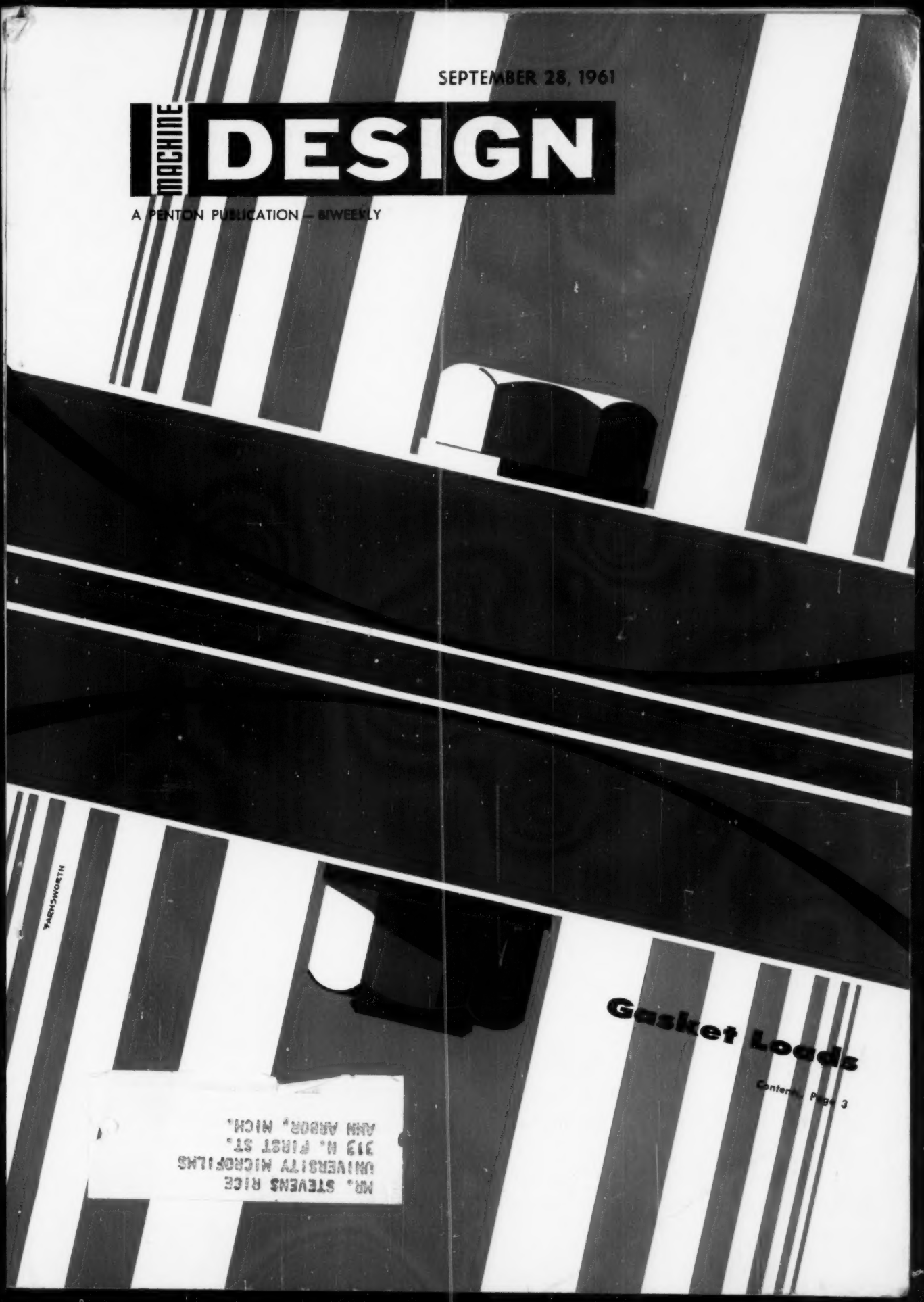
SEPTEMBER 28, 1961

MACHINE DESIGN

A PENTON PUBLICATION — BIWEEKLY



Gasket Loads

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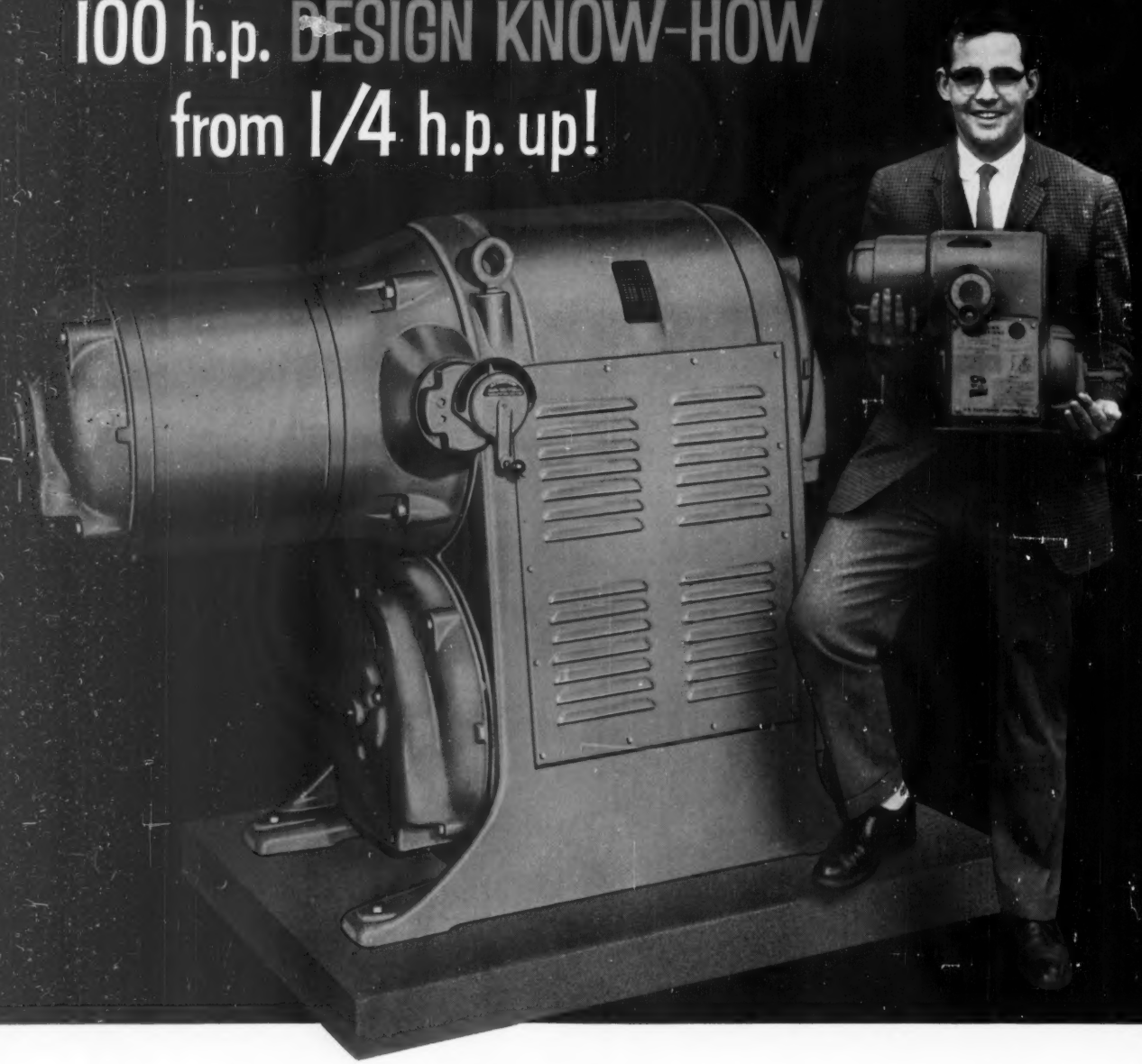

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Circle 201 on Page 19

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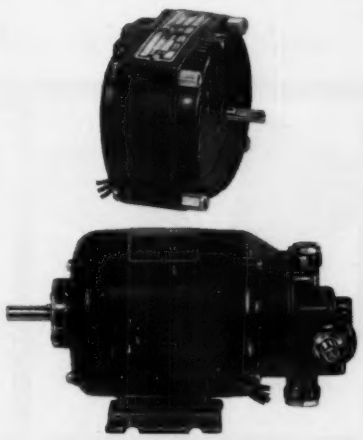

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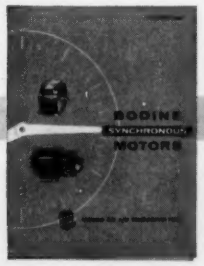

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Circle 204 on Page 19

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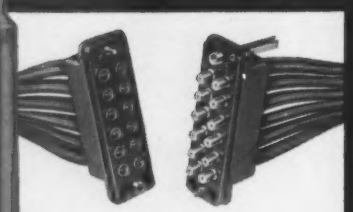
reliable solderless contacts result in dramatic reduction of installation time

wide application—all with snap-locked removable contacts



Type MB-X

Coax in miniature rectangular configurations.

AQUALOK™

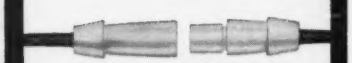
Weather-sealed round connector—either all coax or in combination with single conductors.

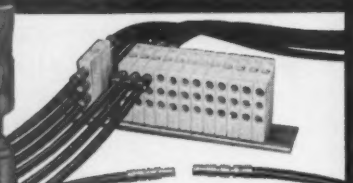
Coax Bantam HYFEN

Connectors for standard and miniature coax—either all coax or in combination with single conductors.

Coax Feed-Thru

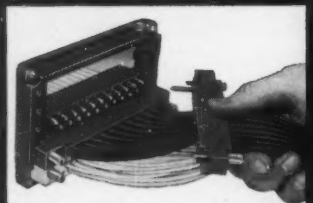
Miniature and standard connector (above) and splice (below). All plastic shells — lightweight, durable, impact resistant.





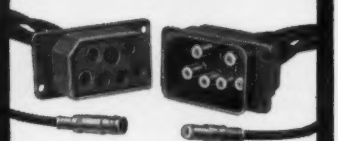
Coax MODULOK®

Modular terminal block with spring-loaded removable contacts.



Type PD-X

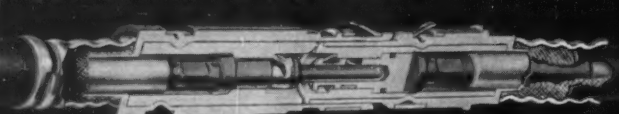
Modular HYFEN inserts for all standard or miniature coax or in combination with inserts for single conductors.



Type ME-X

Rack and panel HYFEN series—features one piece shell, one piece inserts.

Burndy's coax contacts, for both miniature and standard coax cable—feature crimped inner and outer contacts, which provide a more reliable connection, faster and easier. High speed production tooling results in low installed cost—crimps contacts in any circumferential position. Few parts simplify installation. No heat to damage insulation.



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BURNDY 61-6

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Front Cover: Loads on gaskets in flanged joints are far from uniform, as shown by the red force lines on George Farnsworth's cover illustration. On Page 128, authors Nolt and Smoley explain how these gasket loads can be evaluated.

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EDITORIAL OFFICES
Penton Building, Cleveland 13, Ohio

Branch Offices
New York, Detroit, Chicago, Pittsburgh, Washington, London

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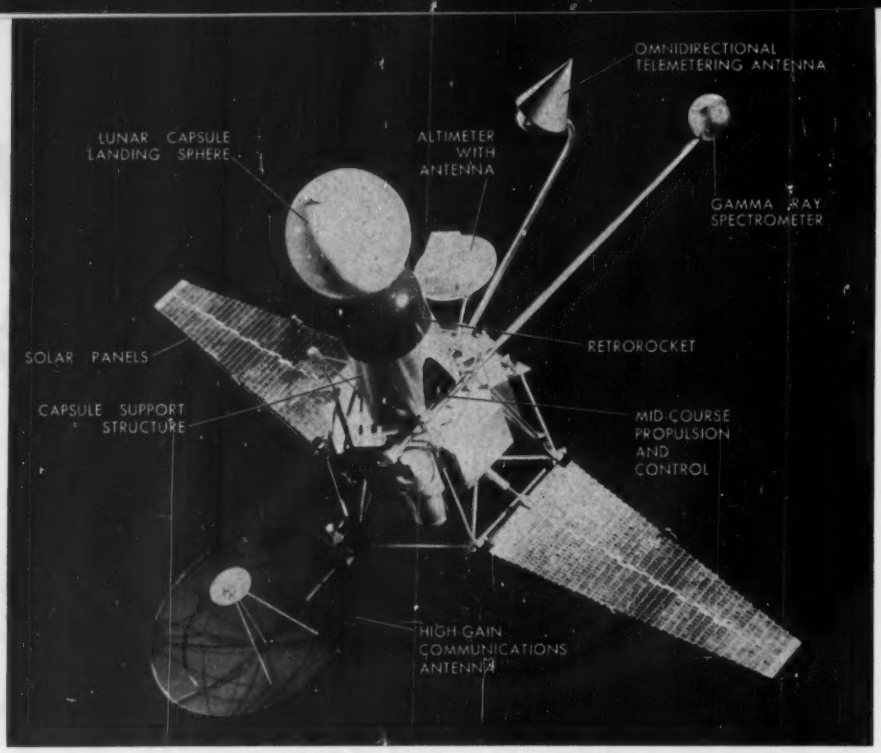
MACHINE DESIGN

ENGINEERING NEWS



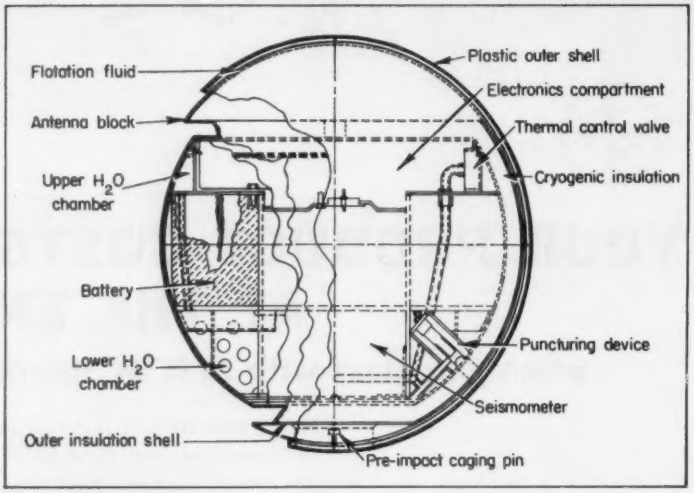
Balsa Shell Will Cushion Moon Capsule's Landing

NEWPORT BEACH, CALIF. — When the Ranger spacecraft streaks nearly a quarter of a million miles to the moon next year, it will end the trip by impacting a small ball-shaped capsule on the lunar surface. The sphere will automatically set up shop and radio lunar-structure data back to earth.

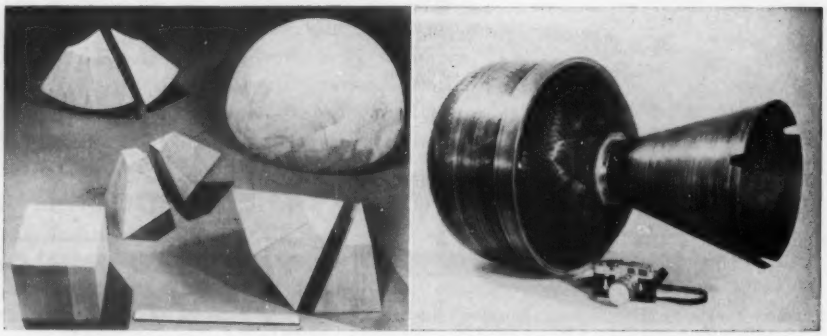
The capsule, designed by Aeronutronic Div., Ford Motor Co., will contain a seismometer to record moon quakes, temperature-recording devices, and numerous other instruments. At a distance of 20-25 miles above the moon, it will be detached from the Ranger spacecraft and a retrorocket will slow it to less than 150 mph prior to impact. Ranger will continue traveling at 5000 mph into the surface.

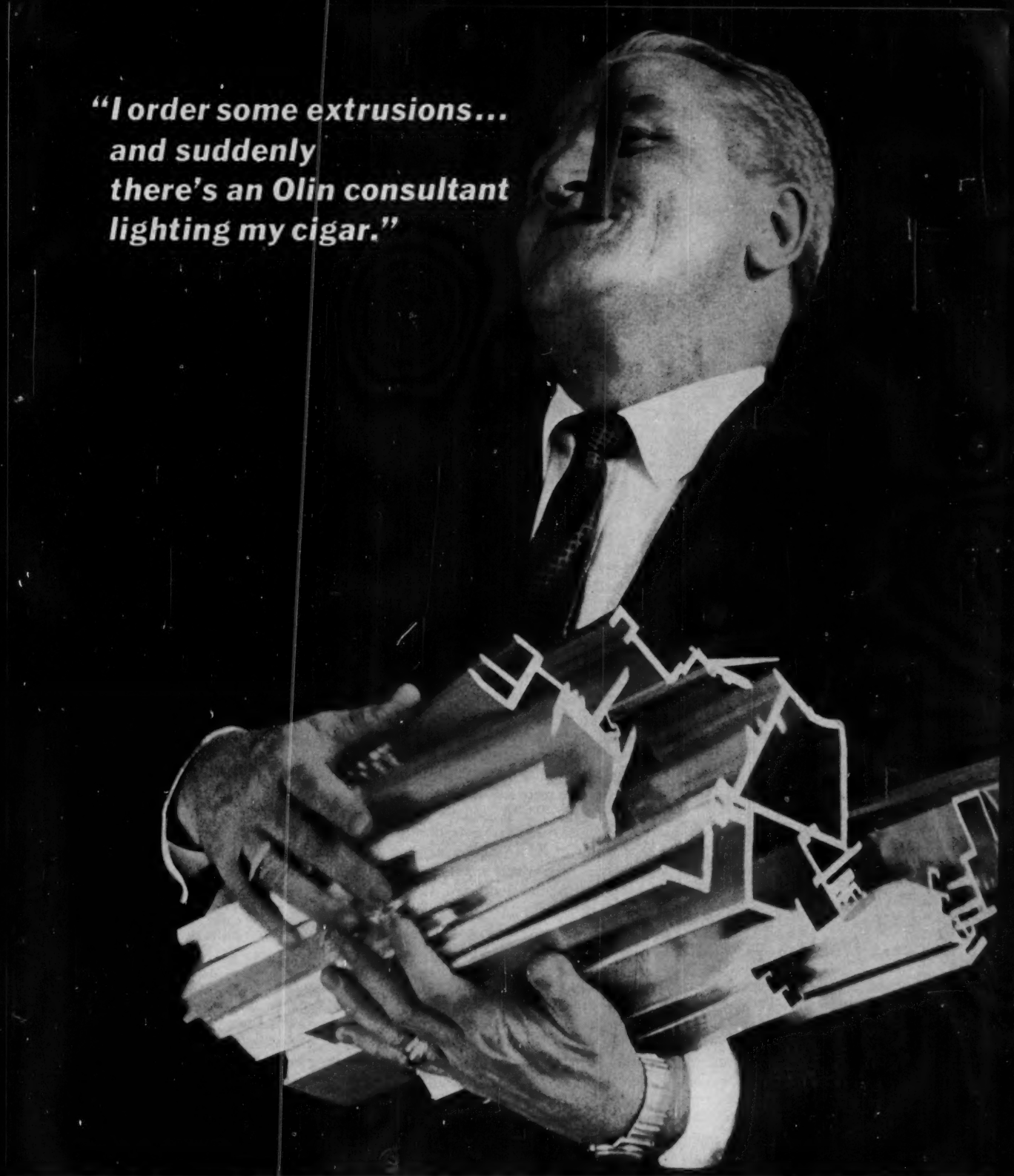
Measuring 25 in. OD, the outer shell consists of a thick layer of balsa wood. Inside this covering is a 12-in. survival sphere that contains instruments. The inside sphere is surrounded by a flotation fluid that will help distribute impact loading. The fluid also allows the sphere to right itself in a vertical position in response to the moon's gravity.

Once it lands, the lunar sphere will gather and transmit messages for several months, even though temperatures on the moon will vary from −250 F at night to 220 F in the day.



Payload capsule will separate from Ranger when the altimeter senses that the spacecraft is within 25 miles of the moon. A small retrorocket (compared in size to a 35-mm camera, below) will slow the instrument package to less than 150 mph; impact shock will be absorbed by the balsa-wood outer shell. Total weight of the survival sphere is 56 lb, which includes 31 lb of instruments, batteries, and wiring, and 7.5 lb of outer shell and flotation fluid.





"This gentleman walks in with a copy of my extrusion order, lights my cigar and starts talking aluminum, aluminum, aluminum. In short, he's telling me how Olin can save me money by making my dies, giving me better design efficiency in my extrusions. Then he shows me a new welding technique and suggests a brand new market for my product! Who'd think you would ever get service like this from one of America's biggest aluminum producers? Smart people down at Olin. They know how to help a man out where he needs it most." Nobody thinks in aluminum better than Olin. Want to talk to one of our consultants? See the Yellow Pages for our local Sales Office.

Circle 207 on Page 19

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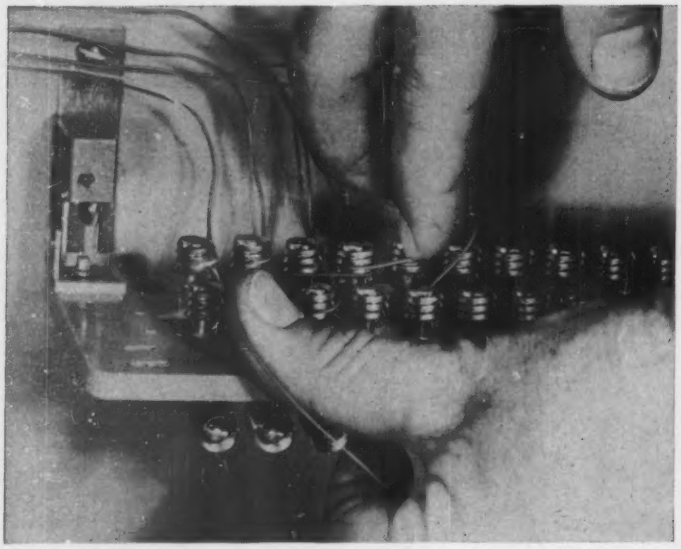
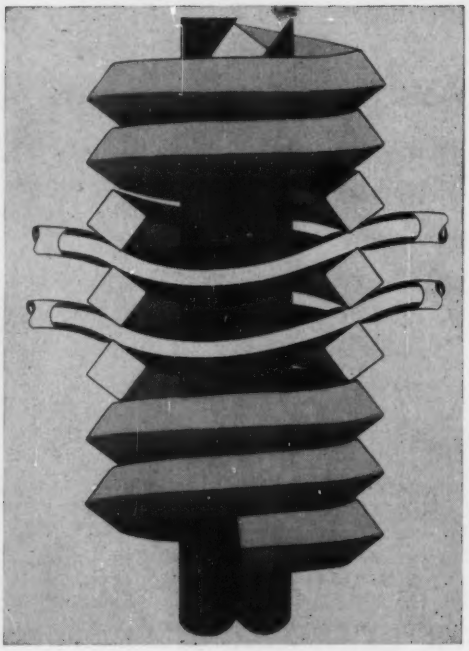
Square-Spring Fastener Bites Into Wire





When looped around a coil-spring connector and pulled tight, plastic-insulated wire is forced between the sharp turns of the coil (left). The edges cut through the insulation to form an electrically stable, vibration-proof contact (right). A wire can be inserted between two turns of the coil and later removed without disturbing other wires connected between other turns. The connector is expected to cut hook-up time on telephone lines in half.

BALTIMORE—A new type of fastener that looks like a coil spring connects plastic-insulated small-gage wires to terminal posts without the aid of lugs, binding posts, or nuts. Developed by Bell Telephone Laboratories, it is expected to become the standard method of joining telephone wires to terminals.

With the new connector, wires can be fastened rapidly without first stripping the insulation. And they can be connected and disconnected without disturbing other wires on the same mounting.

The connector differs from a coil spring in that it's made from square-shaped wire, instead of from round or oval. When looped around the spring and pulled tight, insulated wire is forced between two turns of the coil. The sharp, square edges bite through the plastic insulation and make multiple contacts with the wire. The contacts are electrically stable and vibration proof. Other wires can be forced into other turns of the coil.

The connector is made of tin-plated phosphor-bronze wire about 1/16-in. square. It is wound into a coil of about $\frac{3}{8}$-in. OD and supported by a brass post through the center. Life-tested in highly reactive environments, such as hydrogen-sulfide, under changing temperature conditions, the connector did not fail until long after the telephone wire was useless.

Process Makes Superconducting Magnets Practical

PRINCETON, N. J.—The door is open for mass production and widespread use of superconductive magnets that generate enormous field strengths, but use practically no power. A new metallurgical process makes them possible.

Developed by Radio Corp. of America, the process permits rapid and continuous growth of crystalline niobium-tin. Magnets made from the material will continue to operate indefinitely at near absolute zero temperature after a small voltage starts current flowing.

Until now, there has been no satisfactory way to produce the desired crystal form of the material in quantities necessary for widespread use. Extreme brittleness of the crystalline substance has been the main obstacle. Laboratory apparatus used in the process-development work is capable of turning out uniform crystal coatings of niobium-tin on a fine wire at the rate of 30 ft per hr. Production refinements will increase this rate.

According to the RCA scientists, the finished wire has been used with outstanding success in tests involving as many as 90 turns of wire around a $\frac{3}{4}$-in. form. Tests on short-wire lengths performed at the Lawrence Radiation Laboratory, University of California, indicate that the wire remains superconductive in 94,000-gauss magnetic fields while supporting a current of 7 amp. Current density in the superconductive coating approaches 100,000 amp per sq cm. The tests also indicate the wire can be wound any desired number of turns to form extremely powerful magnets.

It is expected that a niobium-tin wire wound magnet weighing only about 20 lb (exclusive of its accompanying refrigeration equipment), started with a pulse from a 6-v battery, will produce a magnetic field comparable to that of a 100-ton electromagnet operated continuously by a 100-kw power supply.

Fluid Power NEWS

OILGEAR 40 Years of Fluid Power

Report No. 11,807 From Oilgear *Application-Engineering* Files

How OILGEAR *Any-Speed* Drive Systems on revolutionary, new, continuous pipe mill provide up to 30% over and under base lineshaft speed for each stand—controlled to ±0.1% accuracy . . . maintain constant interstand speed ratios.

USER: *Lorain (Ohio) Works, National Tube Division, United States Steel Corp.*
Machine Builder — Aetna Standard Division, Blaw-Knox Co., Pittsburgh, Pa.
Differential Drive Manufacturer — Beloit Iron Works, Beloit, Wis.

PROBLEM: To provide accurate, efficient, independent, variable speed drive and control systems between a 1000hp lineshaft drive and 14 form-weld, stretch-reduce stands, and rotary flying hot saw of a new, continuous, buttweld pipe mill designed to produce approx. 237,000 tons of 1¼" to 4" buttweld pipe annually from flash-welded, endless webs of skelp. Delivery speeds range from 700 ft/min. of 1¼" pipe to 150 ft/min. of 4" pipe.

DRIVE REQUIREMENTS: 1. "Hard", non-resilient characteristics of direct gearing — with provision for infinite, variable speed control of any or all stands from 30% under to 30% over predetermined base lineshaft speed. 2. Accurate, preset, speed ratios between stands, capable of precisely maintaining transmitted differential loads to 150 hp — without drift — regardless of load change or lineshaft speed variation. 3. Optional, remote, automatic, "preset", and remote manual control. 4. Direct-reading, constant, visual indication of torque being pulled at each stand, and speed ratios between all adjacent stands. 6. Drive a rotary, flying cut-off saw at maximum mill delivery speeds — synchronized with speed of last active mill stand. 7. Must be compact, with trouble-free dependability for continuous, heavy-duty drive service. 8. One reputable source and responsibility preferred.

OILGEAR *Application-Engineered* HYTAC* Drive System For Continuous, Buttweld Pipe Mill

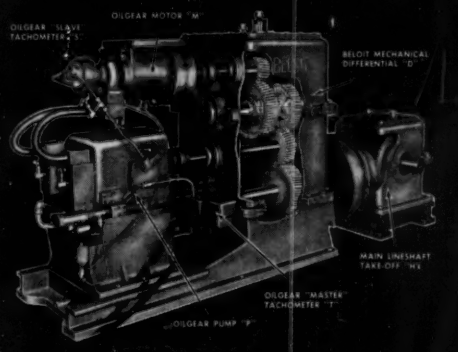
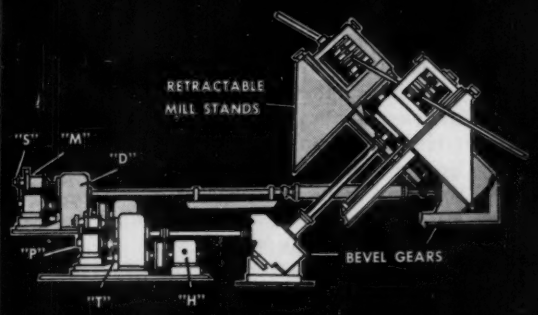


Photo Courtesy of Beloit Iron Works

LEFT: Fluid from Master Tach (T) gives stand drive speed command to control on Pump (P). Slave Tach (S) — direct-connected to Drive Motor (M)—feeds back a flow signal proportional to actual drive speed. Through remote, pushbutton control stations connected to electric pilot motor on Master Tach (T), operator can vary speed of each, or all stands infinitely up to 30% over or under base line-shaft speed . . . with accuracy to ±0.1%. **RIGHT:** Two typical stands of seven stand stretch-reduce mill. Each stand is mounted on a steel sled—45° to horizontal—90° in relation to each other. Sled stands are movable by a hydraulic cylinder. A hydraulic clamping mechanism holds sleds in selected positions. Six pipe sizes can be rolled without changing rolls.



SOLUTION: Oilgear *Application-Engineered HYTAC** — Beloit Mechanical Differential Drives provide precise speed and ratio control for 7 form-weld stands, 7 stretch-reduce stands, and a rotary, flying cut-off saw. Overall mechanical efficiency has been determined as well above 90% at full load . . . with remotely controlled speed variable up to 30% over and under base lineshaft speed for any one or all stands — with accuracy maintained within ± 0.1%. Production speeds required for a given pipe size can be preset within a small fraction of 1% — and duplicated at any later date. In this precisely controlled process — a National Tube innovation — the buttwelded pipe is both elongated and reduced in diameter . . . *with wall thickness and pipe diameter held to extremely close tolerances by the accuracy of interstand speed ratios.* An Oilgear "Any-Speed" Drive and Control System automatically synchronizes the rotary, flying cut-off saw with maximum delivery speed of the last active stretch-reduce stand — to cut the continuous pipe in accurate, predetermined lengths.

BIBLIOGRAPHY: *Steel Magazine, Dec. 12, 1960, Page 86; Automation Magazine, May, 1961, Page 68; Steel Magazine, Jan. 30, 1961, Page 114; A paper — "Variable Speed Hydro-Mechanical Drive", by Charles W. Modersohn, Staff Engineer, Beloit Iron Works, presented at N.C.I.H., Oct. 21, 1960.* ⓘ *See Oilgear Fluid Power NEWS 8, 11, 15, 16 — available on request.*

Installation of Oilgear-Beloit Variable Speed Hydro-Mechanical Drive and Control Systems — successfully pioneered on paper machine drives ⓘ — have exceeded originally specified requirements — without "start-up" problems . . . indicating the value of Oilgear's *Application-Engineering* teamwork throughout all stages of design, building, installation, and testing.

For accurate synchronization of multiple, tandem operations; for combining separate operations to handle webs, tows, or sheets — soft and fragile at one point, strong at another; for continuous operations where tension affects quality — or determines dimensional tolerances . . . all need MORE than conventional drives and controls — they need the precision of Oilgear *"Any-Speed"* Drives and Controls. User's state — *"For the lowest cost per year — with the most advanced, precision controls known to industry . . . it's Oilgear — the pace-setting pioneer!"*

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Please direct inquiries to advertiser, mentioning MACHINE DESIGN

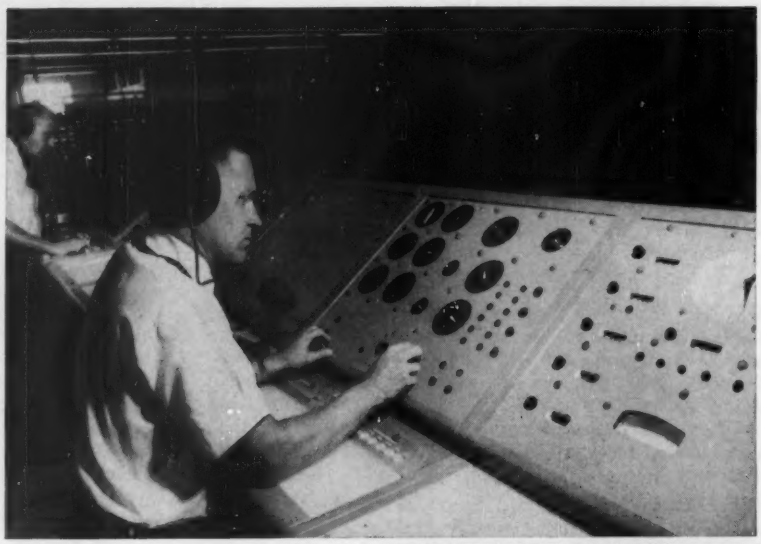
Simulator Teaches Missile Men How to Hunt Subs

DUARTE, CALIF. — Navy personnel who will operate the ASROC anti-submarine weapons are now learning the job on a shore-based trainer. The system, installed at the Norfolk Navy Base, permits missile men to wage realistic practice battles with enemy submarines.

Designed by Ordnance Div., Minneapolis - Honeywell Regulator Co., the trainer consists of a number of electronic consoles that simulate equipment used aboard ships. The consoles locate and track enemy subs, compute their courses, range, and speed, aim the ASROC launcher, and fire the missiles. Sonar, computer, fire control, and launcher subsystems perform as if they were in operation aboard ship.

Honeywell engineers described the trainer as a synthesized operational ASROC system with the same external appearances and functional features of the actual equipment, but with computational and equipment responses simulating, rather than duplicating, the system.

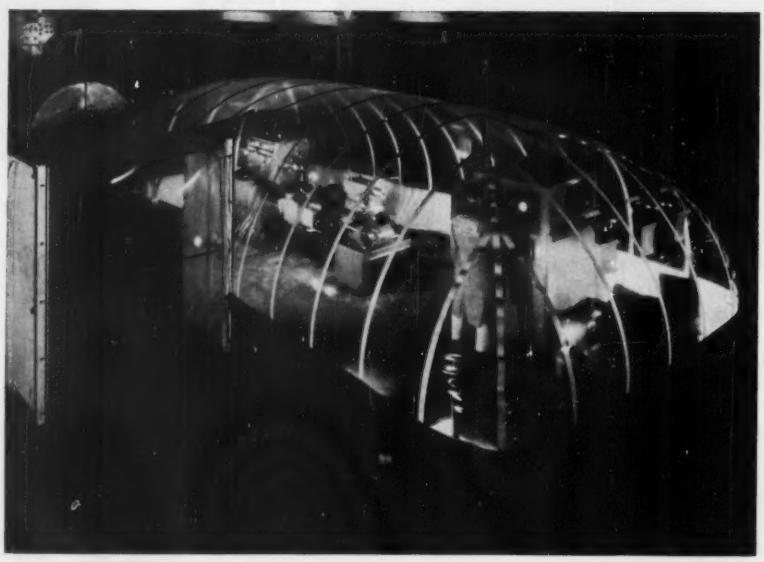
Operation of the trainer requires a combined effort by instructors and trainees. Tactical situations are established, monitored, and controlled by the instructors at a master console, and trainees learn to perform functions required during actual combat conditions.



Instructor's projection room (above) includes a screen and projection system which displays movement of all ships and targets. From the console, action of the entire trainer can be started, monitored, and stopped. The instructor has complete control of the type, complexity, length, and conduct of the problem. The students' equipment includes mockups of an underwater-battery plot, combat information center, ship conning station, and launcher-control station (right). With it, they fight the two submarines commanded by their enemy, the instructor.

Bubble Air Conditions Assembly Line

Some of the newer precision machine tools require novel and ingenious manufacturing techniques. For runoff and inspection of a new lathe, R. K. LeBlond Machine Tool Co., Cincinnati, had to develop a plastic, air-conditioned bubble. Inflated with air the bubble maintains its internal temperature within 5 F of setting, even when temperatures in the rest of the shop are fluctuating 25 F. According to LeBlond, the unit provides ideal conditions for balancing the operating characteristics of the lathe to those of the tape-control system, and since it attaches to the floor by pipe cleats, it can be easily moved from one lathe to another. Measuring 12 x 25 x 9 ft, the unit is supplied by a 10-ton air conditioner. Leakage is kept to a minimum by an air-lock entrance. Waste air cools the rest of the shop.



Designing a machine?

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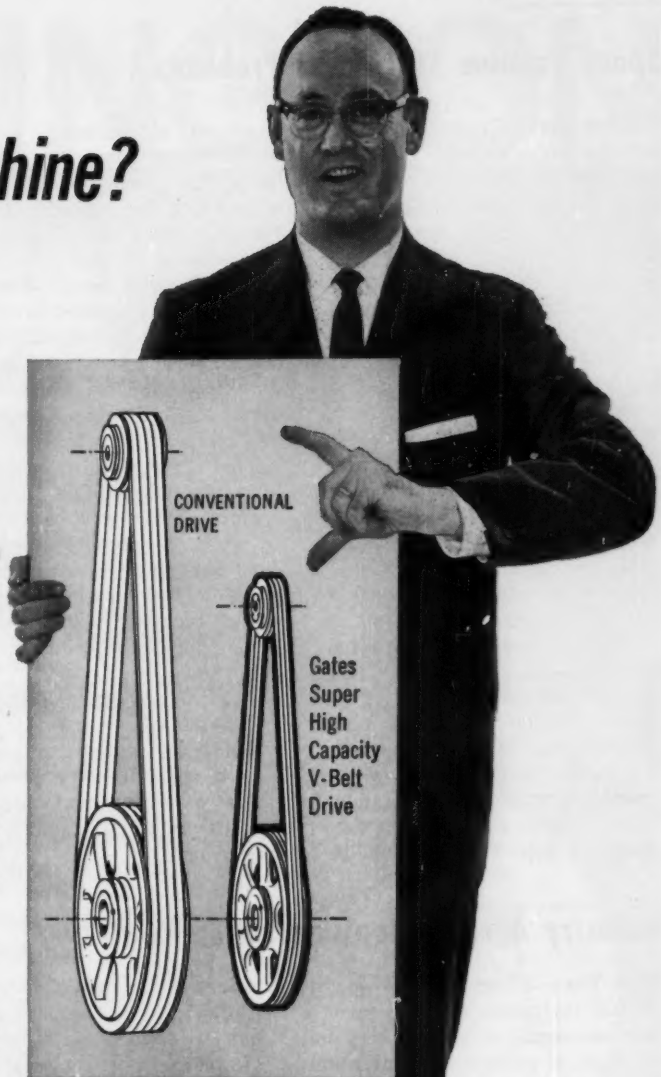
Ask him to design a drive for your machine two ways: a conventional V-belt drive and a new Gates Super HC High Capacity V-Belt Drive. A quick comparison will show you many of the important savings provided by the new Gates drive.

Manufacturers everywhere have standardized upon the Gates Super HC V-Belt Drive—industry's first and most advanced high capacity drive. It is your best assurance that your power transmission unit will not soon become obsolete.

Your local Gates Field Engineer is an experienced, fully-qualified drive design expert. Contact him for drive design help.

The Gates Rubber Company
Denver, Colorado



Gates Super HC Drives give you these benefits:

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- Reduces drive weight 20% and more.
- Cuts drive costs as much as 20%.
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- Belt speed up to 6000 ft/min possible without dynamic balancing.
- Less costly, higher speed motors can often be used.

BP-11

Exclusive design features include:

precisely engineered arched top, concave sidewalls, Flex-Weave cover, super strength tensile construction

Building the future on 50 years of progress

Gates

Gates Super HC V-Belt Drives

Circle 209 on Page 19

Space Vacuum Still Poses Problems

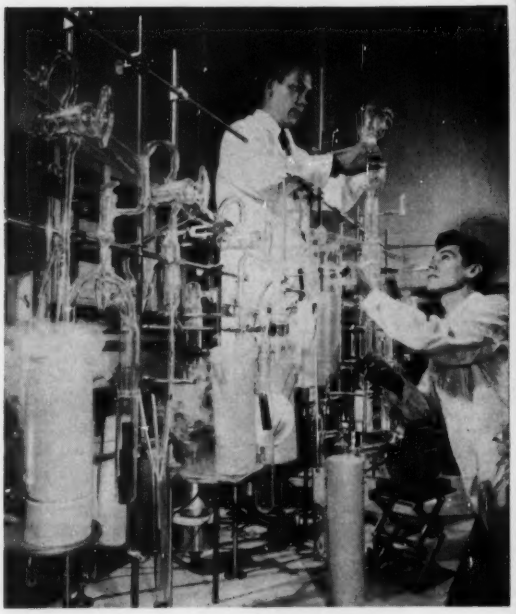
CULVER CITY, CALIF. — The extremely high vacuum of space continues to cause lots of headaches for designers, according to scientists at Hughes Aircraft Co. Experiments probing the effects of super vacuums on materials bring to light a host of perplexing problems:

- Whole sections of a space vehicle may disappear because of metal evaporation.
- Machines that run smoothly on earth may quickly grind to a halt because of vaporization of grease and other lubricants.
- Metals touching each other cold-weld together in a few days because of molecular attraction and lack of surface films.
- High vacuum destroys some plastics, sapping their strength by evaporating their plasticizers. On the other hand, high vacuum protects other plastics by improving their properties.

Because of metal evaporation, gaseous metal condenses on surrounding objects. This could be disastrous to electronic circuits which might short out and to lenses and other optical equipment which could become coated. However, there are solutions to the problem, Hughes researchers report. Certain anodic coatings reduce metal-loss rates by a factor of 70. While cadmium, zinc, and some magnesium alloys are very susceptible to evaporation, iron, steel, titanium, tungsten, and platinum are resistant.

The biggest problem is that of lubricant vaporization. Bearing seizure and cold weld of electrical contacts, commutator brushes, etc. will certainly result if designers don't come up with new techniques. Ideas which show promise and are now being checked out include:

- Use low-vapor-pressure greases to lower evaporation rate.
- Construct bearings from materials which don't need grease.
- Use solid-film lubricants.
- Maintain pressure at the surface of bearings.



A maze of glass tubing, including vacuum chambers and liquid-nitrogen traps, takes everything from germs to materials samples on a simulated space ride at the Hughes Laboratories. Experiments designed to shed light on engineering problems have turned up other data too. Micro-organisms, for example, evaporate in a super vacuum; the outside of a space craft won't have to be decontaminated.

Industry Agrees 'Stop Convention Recruiting'

NEW YORK—More than 75 per cent of 200 companies querried favor a ban on recruiting of engineers and scientists at professional conventions and meetings. An even larger group, 87 per cent, indicated that it would abide by a general industry agreement to halt all convention recruiting. The companies, all of whom actively recruit, responded to a survey by Deutsch & Shea Inc.

Many companies base their "yes" answer on the belief that recruiting is seriously interfering with normal convention activities. "I have long felt," commented the division manager of a major electronics company, "that heavy recruiting activities have sapped the vitality of the technical conventions and are rapidly degenerating the quality of the meetings."

Asked, "If industry agreed generally to halt such recruiting, would you recommend your company abide by this agreement?" Participating organizations lined up heavily in favor: Yes—87 per cent; no—9 per cent; no answer—4 per cent.

Several companies are already considering independent action to halt or retrench recruiting activities. However, 30 per cent say they can't quit because they are already recruiting for purely defensive reasons.

Policemen Are Needed

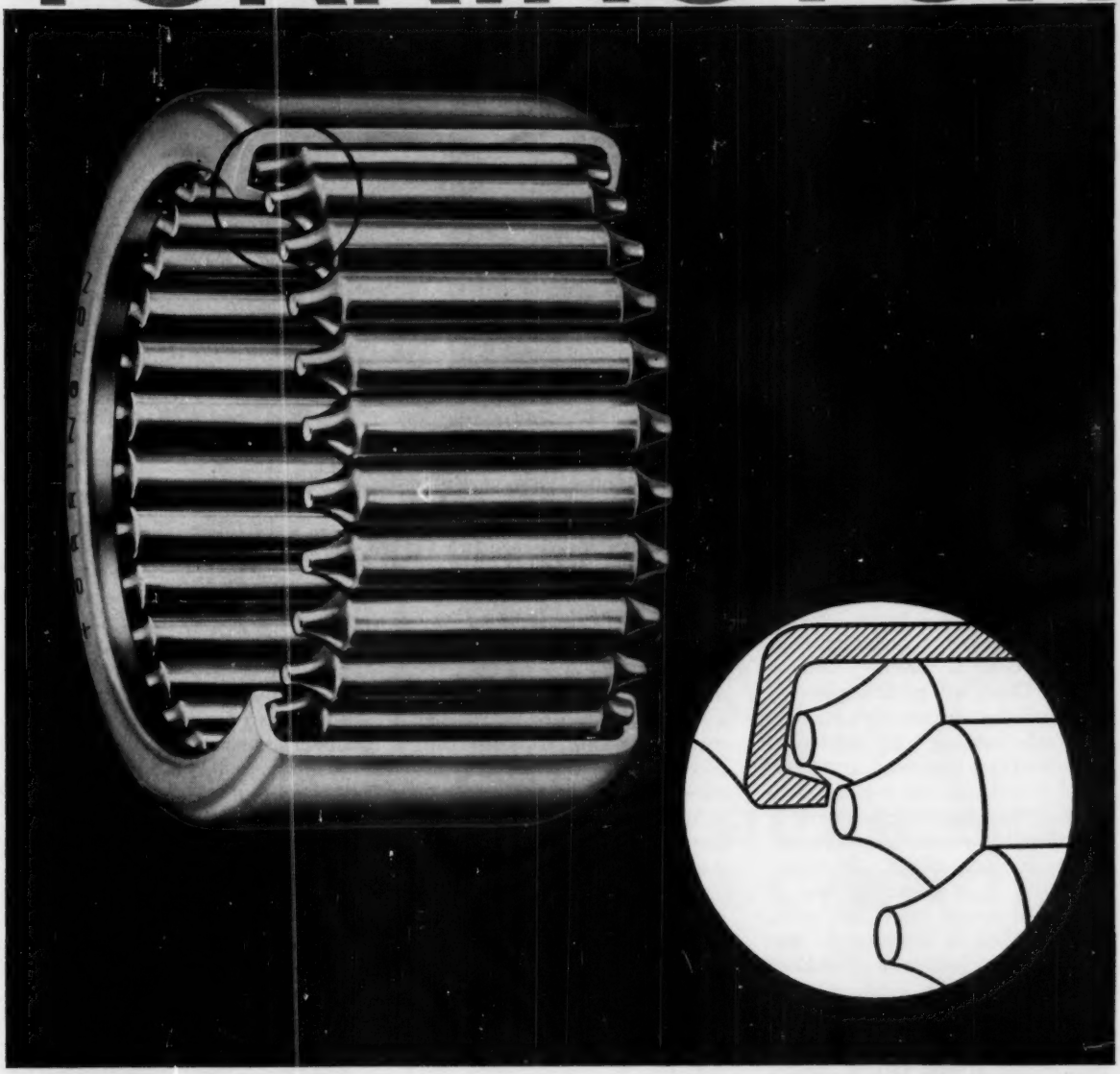
The problem of enforcement is the major obstacle to an effective ban, according to the survey. Many companies doubt that a workable system can be developed, others believe that mass-search organizations, employment agencies, etc., would double their efforts.

Response to the survey shows a clear indication of industry's deep concern with the problem of conventions recruiting, but few companies will change their policy unless all companies do. The solution recommended by Deutsch & Shea lies in the control of recruiting by the individual societies in the manner pioneered and now established by American Chemical Society and American Institute of Physics.

Convention recruiting that is controlled and operated by societies is acceptable ethically and professionally to individuals and industry alike, D&S concludes, and would protect the fundamental role of the societies, as well as reduce recruiting costs significantly for each company. A New England executive comments: "The exercising of proper control over the use of sponsored technical-society placement arrangements . . . would be much more effectual and positive a position to take than the effort to ban a basically logical setup on the basis it is being misused."

Sixty-five per cent of the organizations taking part in the survey currently recruit at conventions. Of this group, almost one third recruit at three conventions annually. In terms of employment of engineering and scientific personnel, the 200 organizations range in size from firms employing less than a hundred (20.5 per cent of the sample) to those employing a thousand or more professional men (17 per cent).

TORRINGTON



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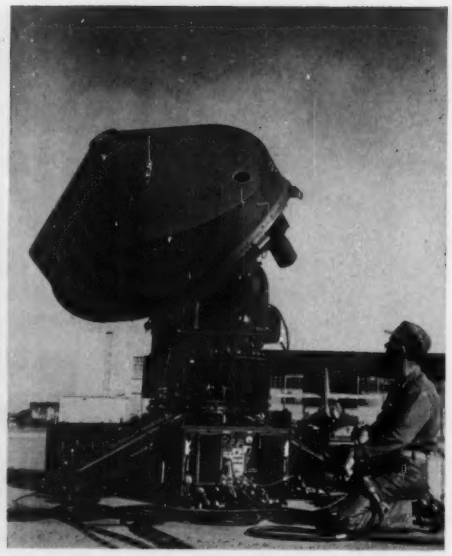


Radar, a computer, and radio-command equipment will be teamed up in an automatic landing system for space vehicles. Designed to start tracking targets when they are 500 miles out, the system will guide powered or unpowered craft traveling at speeds up to 10,000 mph. The radar will be the standard AN/TPQ-10 model originally developed by GE for the Marines and used for close air support of front-line ground forces.

Flight-path control and buckling gear:

Energy Killers for a 10,000-mph Approach

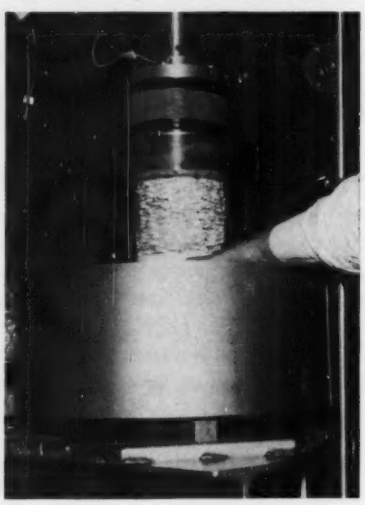
SYRACUSE, N. Y.—An automatic-landing system, now under development at General Electric's Defense Systems Dept., will guide unpowered space vehicles and reusable boosters to a safe landing. By combining radio-tracking, computer, and command techniques, the system solves the problems of energy management and dissipation after a vehicle reenters the atmosphere. It is designed to start watching over a homeward-bound craft 500 miles out, calculate a flight path that will allow the vehicle to slow down safely, and furnish guidance to a predesignated runway.

Over 100 landings have already been simulated with various homing systems on an analog computer, and the system now being developed is ready for application to specific vehicles, according to GE. Tailored to the capabilities of each vehicle, the system will furnish instructions on how to dissipate excess kinetic energy without overheating or overstressing. Control of flare and landing maneuvers will be accurate to a sinking speed of 2 fps in normal wind conditions at a landing speed of 100 fps.

The system will be equally applicable to manned and unmanned vehicles arriving at velocities of more than 15,000 fps, according to GE. By working with performance characteristics of individual space craft, the system will calculate and store a series of safe flight paths in a computer. One approach can be selected depending on position and velocity conditions.

Another new research project reported by GE is one that graduates the childhood pastime of smashing tin cans into a space-age technique. Researchers at the company's Missile and Space Vehicle Dept., Philadelphia, will spend the next year studying buckling of metal cones and cylinders. They have already found that the cylinders absorb large amounts of energy under impact buckling, and that energy is distributed in a precise manner causing pattern-like crumpling. The scientists believe that crumpling cylinders could be expendable landing gear for spacecraft.

While advanced landing systems are rapidly shaping up, GE has also passed a milestone in development of a space drive. A repetitively pulsed plasma-propulsion engine has now been fired continuously for 60 hr at a rate of 1000 firings per min—a record for this type of device. According to GE, this is about the same amount of work the engine would get in one year in space. The engine was operated in a 13-ft vacuum chamber that maintained pressure of 5 x 10^{-6} mm of mercury to prevent interaction between plasma exhaust and residual gas in the test chamber.



Metal cylinders buckle in a definite pattern when crushed. GE engineers are working on dynamic buckling of shell structures to develop expendable landing gear for space vehicles. The gear, designed for one landing on the moon, would absorb impact energy as it buckles, would be left behind when the vehicle takes off for home.

Loss of Creativity Called Management's Fault

Researchers Must Be Persuaded To Adopt Company Goals

PHILADELPHIA—When industrial researchers are treated solely as scientists, they lost part of their creative abilities. So said Raymond Stevens, president of Arthur D. Little Inc., Cambridge, Mass., at the recent IRE-sponsored Conference on Technical and Scientific Communications. Mr. Stevens stressed that while creativity and innovation are among the great American resources, they require more executive attention and support than they've been getting.

By regarding industrial research workers solely as professional specialists, management limits them to finding their rewards in professional behavior and unduly restricts their contributions to the company, Mr. Stevens explained. More direct relationships are necessary between R&D staffs and top management if the company is to make the most of its creative talents. The idea is to get the researchers to make company goals their own; they can then contribute to many aspects of the organization and have greater interest in working for its growth.

Maintain the Momentum

Other suggestions by Mr. Stevens had to do with keeping creative people creating:

- When a new man joins the staff, assign him his own research problems at the earliest possible date.
- Structure the flow of patent disclosures directly from the researchers to the patent attorney—competent engineers don't need the intervening "help" of group leaders or research directors. The prime function of a research director is to foster invention by his staff, and he should be measured by his staff's accomplishments.

New ideas need active support and promotion, Mr. Stevens continued. This may be one of top management's important functions; the Rolls-Royce trademark is a monument to the joint efforts of an inventive engineer and an astute entrepreneur. Without communication between management and the creative inventor, promotional support of new ideas cannot occur.

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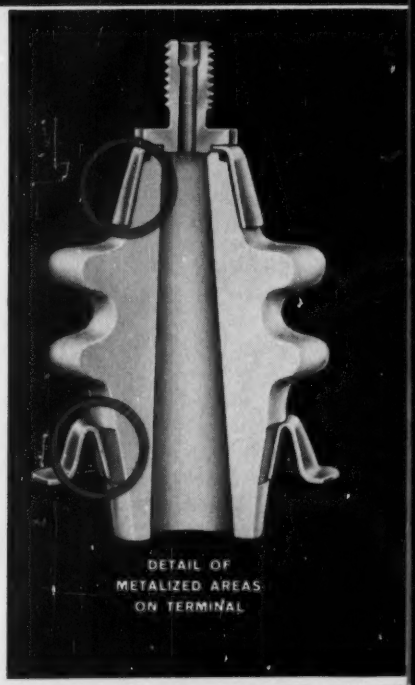
Circle 211 on Page 19

Metalized Bond Now Over 15,000 PSI

Advanced metalizing and brazing techniques at Coors now produce bond strengths better than 15,000 psi. Test parts, as shown above, are being considered for standard ceramic-to-metal test specimens by ASTM. These Coors test parts are run with each group of customer parts to guarantee specifications. Coors is presently metalizing and brazing parts of large mass and complex design, using these high strength techniques. For the newest techniques in high temperature, high strength ceramic-to-metal assemblies, write for Technical Data Sheet No. 0500, "How Ceramic-To-Metal Seals Are Made"—or call your nearest Coors Regional Sales Manager: WEST COAST, *William S. Smith, Jr., EM 6-8129, Redwood City, Calif.;* MIDWEST, *John E. Marozeck, FR 2-7100, Chicago, Ill.;* CENTRAL, *Donald Dobbins, GL 4-9638, Canton, Ohio;* EAST COAST, *John J. McManus, MA 7-3996, Manhasset, N.Y.;* NEW ENGLAND, *Warren G. McDonald, FR 4-0663, Schenectady, N.Y.;* SOUTHWEST, *Kenneth R. Lundy, DA 7-5716, Dallas, Texas;* SOUTHWEST, *William H. Ramsey, UN 4-6369, Houston, Texas.*



DETAIL OF METALIZED AREAS ON TERMINAL

Coors

ALUMINA CERAMICS

Coors Porcelain Co., Golden, Colo.

Circle 212 on Page 19

Reader Information Service

Circle number on Yellow Card for

- Free catalogs, bulletins, literature
- Information about new parts, materials
- Design data on advertised products
- Extra copies of editorial articles

HELPFUL LITERATURE

Descriptions of items start on Page 176. Starred items are from Sept. 14 issue.

Electrical, Electronic

409 **Mica Capacitors.** 18 pp. Erie Electronics Div., Erie Resistor Corp.
419 **Switching News.** 8 pp. Micro Switch Div., Minneapolis-Honeywell Regulator Co.
423 **Photoelectric Control.** 6 pp. General Electric Co.
426 **AC Motor-Run Capacitors.** 4 pp. New Bedford Div., Aerovox Corp.
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490 **Integral-Horsepower Motors.*** Full line of ac general-purpose units for standard voltages, frequencies. Bulletin L-3314A, 6 pp. Kingston-Conley Inc.
491 **Wound-Rotor Motors.*** Range in size from 1 to 30 hp. Bulletin 104, 4 pp. Louis Allis Co.
492 **Solderless Terminal Blocks.*** Connecto-Block units for use in communications, data processing. Bulletin K 2-5, 4 pp. Thomas & Betts Co.
493 **AC Motors.*** General-purpose ac units drive a variety of machines. Bulletin L-3313A, 6 pp. Kingston-Conley Inc.
494 **Dial Timer.*** Data on Series 305B automatic reset unit. Bulletin N-305B, 8 pp. Automatic Timing & Controls Inc.
495 **Indicator Tubes.*** Wide-viewing-angle series of Nixie units described. 8 pp. Electronic Components Div., Burroughs Corp.
496 **Trimming Potentiometer.*** Microminiature, 3/8-in. square unit has power rating of 1 w at 50 c. 2 pp. Techno-Components Corp.
497 **Synchronous Motors.*** Covers 385 types with ratings from 1/2000 to 1/6 hp. Bulletin 1036, 20 pp. Bodine Electric Co.
498 **Panel Meter.*** Style 42, 4½-in. rectangular unit. 2 pp. Helipot Div., Beckman Instruments Inc.
499 **Armored Cable.*** Complete list of fittings and accessories for interlocked armored cable. Folder F11-135, 4 pp. Thomas & Betts Co.
500 **Miniature Pushbuttons.*** Industrial, miniature, oiltight units. Bulletin GEA-7127A, 12 pp. General Electric Co.
501 **Control Synchro.*** Size 23 unit for 400-cycle operation. Bulletin CS-4-23-2, 2 pp. Vernitron Corp.
502 **Terminal Panel Wiring Block.*** Termi-Blok, for use in switchboards, control panels, instrumentation. 4 pp. AMP Inc.
503 **Standard Relays.*** More than 40 standard relays, and over 450 variations. Catalog 100, 8 pages. Potter & Brumfield Div., American Machine & Foundry Co.
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508 **AC Capacitors.*** Expanded air conditioner and refrigeration lines of motor-run, motor-start ac capacitors. Catalog MS 61-10, 16 pp. Aerovox Corp.

Hydraulic, Pneumatic

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523 **Pressure Tubing.*** Basic principles of welded tubing for boiler, heat exchangers, condensers. Form T-201, 4 pp. Rome Mfg. Co., Div., Revere Copper-Brass Inc.
524 **Quick-Disconnect Couplers.*** Self-sealing Magnum series for 10,000 psi pressures. Sheet L-6103-2, 4 pp. Bruning Co.
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Mechanical Equipment

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Manufacturing Processes, Parts

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532 **Metallized Ceramics.*** Compositions frequently used as metallized or ceramic metal adjoinments. Bulletin 612, 16 pp. American Lava Corp.
533 **Sheets, Rods, Tubes.*** Technical data, properties of laminated epoxy materials. Technical Bulletin 11, 200 B, 6 pp. Continental-Diamond Fibre Corp.
534 **Teflon Products.*** Teflon and Salox rings, packings, molded parts, extrusions, machined parts. Bulletin R 3017, 8 pp. Allegheny Plastics Inc.
535 **Aluminum Ingot.*** Covers one new composition, two alloys available as ingot. Form 28-11596, 12 pp. Aluminum Co. of America.
536 **Thermoplastic Materials.*** Specifications and applications for nine widely used materials. 26 p. Conneaut Rubber & Plastics Co.
537 **Polypropylene Material.*** Data on properties of No. 1014 general-purpose, injection-molding grade, and others. 12 pp. Avisun Corp.

HELPFUL LITERATURE (Cont.)

Design Theory, Techniques

538 Heat-Transfer Problems.* Graphical solutions to various heat-transfer problems. Design Manual HDM-761, 12 pp. Electrofilm Inc.

Engineering Dept. Equipment

405 Strain Recording. 20 pp. Brush Instruments Div., Clevite Corp.

414 Profilometer Instrumentation. 12 pp. Micro-Metrical Mfg. Co.

427 Control Equipment. 6 pp. Boonshaft Fuchs Inc.

539 Photographic Line.* Covers engineering and other industrial photographic papers and films. 24 pp. Anken Chemical & Film Corp.

540 Portable Testing Instruments.* Complete data on models, accuracies, ranges, features. Bulletin Z-54, 8 pp. Weston Instruments Div., Daystrom Inc.

541 Tape Recorder-Reproducer.* VR-2600 wide-band unit covers data from dc to 500 kc. Bulletin 2600, 4 pp. Consolidated Electrodynamics Corp.

542 Disc Indicators.* For use in measuring and control systems. Bulletin 4410, 6 pp. Electronics & Instrumentation Div., Baldwin-Lima-Hamilton Corp.

543 Power Supplies.* Supplies selection data to match requirements; covers 17 models. 16 pp. NJE Corp.

544 Analytical Instruments.* Specification and application data on seven units for research, production control. 28 pp. Philips Electronic Instruments.

545 Digital Instruments.* DC, ac/dc digital voltmeters, preamplifiers, scanners, readouts. Catalog 19-92, 4 pp. KinTel Div., Cohu Electronics Inc.

546 DC Amplifier; Power Booster.* All-solid-state A-2 amplifier; booster G-2 for use with amplifier. Bulletins 031, 032, 6 pp. Ridgefield Instrument Group.

547 Shaft-Position Encoder.* Model 212, 11-digit, photoelectric unit. Bulletin 041, 4 pp. A R & T Electronics Inc.

NEW PARTS, MATERIALS, ENGINEERING EQUIPMENT

Descriptions start on Page 182

Electrical, Electronic

441 Fault indicator resists vibration from 10 to 500 cycles at 10 g. Precision Meter Div., Minneapolis-Honeywell Regulator Co.

443 Germanium transistors provide voltage ratings to 60 v. Semiconductor Products Dept., General Electric Co.

453 Edge-reading motor can be stacked or easily assembled. Electro-Mechanical Instrument Co.

457 Fractional-horsepower motors in sizes 12 and and 15. Transco Products Inc.

463 Permanent-magnet motor is 1-in. diam unit which meets MIL-M-8609 (ASG). Motors & Components Div., Barber-Colman Co.

467 Synchronous reluctance motors in 1 to 5-hp units. General Electric Co.

473 Miniature potentiometer has resolution from 229 to 900 turns. Borg Equipment Div., Amphenol-Borg Electronics Corp.

476 Induction motor is 1/7-hp unit for continuous duty. Kearfott Div., General Precision Inc.

478 Limit switches are oiltight units with flexibility of operation. Cutler-Hammer Inc.

Hydraulic, Pneumatic

444 Bleeder valve has 7000 psi proof pressure, 14,000 psi burst pressure. Fluid Regulators Corp.

449 Slide valve is a midget solenoid unit for pressures to 1400 psi. Herion Inc.

451 Pneumatic couplings are available in three new types. Dyna-Quip Div., Stile-Craft Manufacturers Inc.

456 Pressure regulator has maximum operating temperature of 200 F. Wilkerson Corp.

462 Rotary manifold for pressures to 250 psi is miniature unit. Clippard Instrument Laboratory Inc.

465 Pneumatic vibrator is 3 in. long and weighs 5 oz. Brandford Co., Div., Electro-Mechanics Inc.

470 Check, relief valves have cracking pressures from 5 to 150 psi. Manatrol Corp.

471 Compression spring filter filters high volumes of any fluid. Chrom-O-Lite Co.

474 Hydraulic cylinders for operation to 3500 psi. Sheffer Corp.

477 Small gate valve in union or bolted-bonnet design. Lunkenheimer Co.

480 Large-capacity pumps for pressures to 200 psi. Viking Pump Co.

Mechanical Equipment

440 Intermittent-drive unit has smooth accelerating, decelerating indexing motion. Precision Indexing Drives Inc.

446 Overrunning clutches provide torques from 5 to 500 lb-in. International-Mechanisms.

450 Electric gear transmission is available in horsepower from 1 to 40. Electromatic Inc.

458 V-pulley idlers for A and B-section V- belts. Brewer Machine & Gear Co.

479 Gear unit is packaged, right-angle type. Crown Gear Co.

481 Solenoid-operated brake for shafts to 3/8 in. has braking torque of 2 to 4 lb-in. Midwest Automatic Inc.

Assembly Components

442 Quick-release fastener is quarter-turn, one-piece nylon unit. Elastic Stop Nut Corp. of America.

447 Angle-type counters have torque levels down to 0.1 oz-in. Kearfott Div., General Precision Inc.

452 Quick-release pins incorporate positive lock against accidental removal. Hartwell Corp.

455 Lid support, hinge for high-fidelity, radio, and television cabinets. National Lock Co.

460 Quarter-turn fastener for use in blind fastenings is one-piece unit. Palnut Co., Div., United Carr Fastener Corp.

464 Hitch pin has pointed end for proper alignment of holes. Rein Leitzke.

466 Starts counter is a tiny unit which weighs 3/4 oz, is 1/2 in. square. A. W. Haydon Co.

468 Dowel pins of stainless steel in 1/32 to 1/2 in. diameters. Star Stainless Screw Co.

472 Insulated rivets have large-diameter oval heads. Pylon Co. Inc.

475 Drawer handles, hinges are fabricated of nylon. Hardware Designers Inc.

483 Shock absorbers in 2 and 4-in. bore diameters. Ellis Fluid Dynamics Corp.

Materials

445 Vinyl surfacing material for decorative use over metal, wood, other subsurfaces. Industrial Div., Armstrong Cork Co.

448 Epoxy adhesive is conductive material filled with silver. Conap Inc.

454 Laminated-panel adhesive has operating temperature range from −32 to +200 F. Adhesive Div., United States Stoneware Co.

459 Anodized aluminum foil has wood-veneer finishes. Anodyne Inc.

461 Pressure-sensitive adhesive is one-part material with good heat resistance. B. B. Chemical Co.

469 Corrosion-resistant alloys have good fabricating and finishing qualities. Universal-Cyclops Steel Corp.

482 One-part adhesive requires no mixing prior to use. Rubba Inc.

Engineering Dept. Equipment

484 Electronic circuit template has symbols sized for 0.2-in. grid. Quintec Instrument Co.

485 Portable strain indicator gives fast operation with strain gages and transducers. Electronics & Instrumentation Div., Baldwin-Lima-Hamilton Corp.

486 Drafting unit provides easy access from front of board. Charles Bruning Co.

487 Tape recorder is a miniature unit which resists 1000 g shock. Borg-Warner Controls Div., Borg-Warner Corp.

488 Character generator can be used with any cathode-ray tube display. RMS Associates Inc.

EDITORIAL ARTICLES

Single copies of the following articles are available as long as the supply lasts. Starred items are from previous issues. See Page 223 for other available reprints. Editorial content of MACHINE DESIGN is indexed in the Applied Science Technology Index and the Engineering Index, both available in libraries. Microfilm copies are available from University Microfilms, 313 N. First St., Ann Arbor, Mich.

20-1 The '62 Cars. Feature minor styling changes, engineering innovations, new compact models. (5 pp.)

20-2 How To Evaluate Engineering Proposals. Evaluating bids for engineering and research services. (5 pp.)

20-3 Gasket Loads. Four techniques for evaluating flange pressure factors to improve flanged-joint design. (7 pp.)

20-4 Dowel Embossings. Ways in which ordinary sheet-metal "dimples" can be used. (2 pp.)

20-5 Control Panel Design. Five approaches to laying out control panels. (3 pp.)

20-6 Plastic Piston Rings. Using nonmetallic piston rings to avoid product contamination in reciprocating-equipment applications. (3 pp.)

20-7 DC Motor Control (Part 6). Basic concepts behind a system for obtaining a wide range of motor speeds. (6 pp.)

20-8 Copper-Alloy Extrusions. Specifying and designing copper-alloy extrusions. (7 pp.)

20-9 Pin-Joint Design. Nomograph design procedure for matching joint proportions to operating requirements. (4 pp.)

20-10 Selecting Lightweight Metals (Abstract). New criterion based on strength, ductility, and cost. (2 pp.)

19-3 Statistical Dimensioning Program.* Setting up a program to improve the way assemblies function, while allowing all possible dimensional tolerance. (6 pp.)

19-4 Flexible Couplings.* How to design couplings that use an elastomeric flexible element. (6 pp.)

19-5 High-Temperature Brazing Alloys.* Properties and applications of nickel-base brazing compositions for high-temperature metals. (4 pp.)

19-11 Quadratics-Cubics-Quartics.* Three methods, based on nomograms, to get quick, direct answers; procedure for refining roots to any degree of accuracy. (8 pp.)

18-2 Engineering and Research Reports.* Developing effective technical reports; seven most important kinds. (6 pp.)

18-3 Flame-Sprayed Coatings.* Four methods of flame-spraying protective coatings; guide to material selection, design of flame-sprayed parts. (11 pp.)

17-4 Critical Speeds of Coupled Machines.* Method for determining the critical speed, or natural lateral frequency, of an entire system. (7 pp.)

17-7 Radii of Gyration.* Nomograms for determining K^2 where multiple dimensions occur. (5 pp.)

16-3 Wire-Rope Assemblies.* Selecting wire rope from standard types; designing assemblies. (9 pp.)

16-5 Impact Loads.* Predicting effects of suddenly applied loads; designed efficient structural parts. (9 pp.)

15-3 Chemical Cleaning of Metal Parts.* Selection considerations; description of chemical metal-cleaning processes. (8 pp.)

15-8 Gas-Operated Mechanisms.* Nondimensional graphs simplify calculations of velocity, distance, time. (3 pp.)

14-3 New Roller-Chain Horsepower Ratings.* Getting the most out of the new horsepower and speed ratings proposed by chain manufacturers. (4 pp.)

14-8 Stepped Shafts and Nonuniform Beams.* Predicting deflections at any point in a stepped shaft or variable-section beam. (6 pp.)

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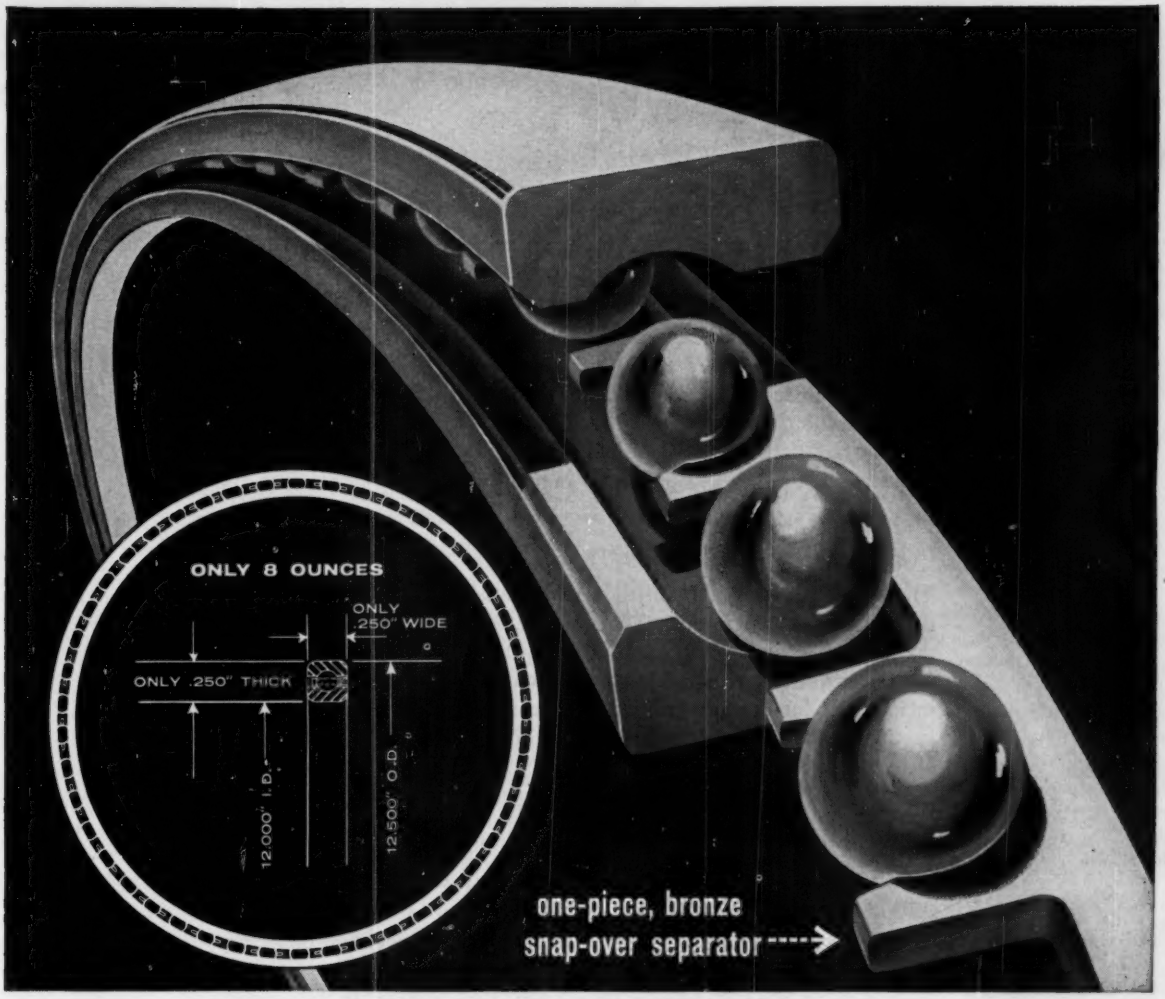

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Kaydon reduces Reali-Slim bearing "off-the-shelf" prices additional 24%

90 sizes—4" to 12" bore—
1/4" to 1" width and cross-section

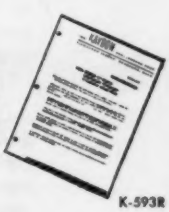
Due to advantages made possible by greater sales and increased production efficiency, Kaydon now passes along another price reduction on "off-the-shelf" Reali-Slim Type CP Bearings. This new price cut (up to 24%) has been made in addition to reductions up to 76% a year ago.

Save on bearing cross-section and weight—Reali-Slim is the world's thinnest radial ball bearing. Many sizes of type "CP" are less than 15% of the weight, 34% of the width and cross-section of comparable, extra-light bearings.

Type "CP" with new one-piece, bronze snap-over separator — Major applications include machine tools; farm, textile and paper machinery; printing presses; pumps and gear boxes; missiles, aircraft and radar; gun turrets and dozens of related installations.

Kaydon bearing engineers are prepared to give you valuable help with technical applications of thin-section bearings.

New "CP" Reali-Slim bearing bulletin includes prices — gives you full details on these 90 sizes of Reali-Slim bearings with Conrad deep-groove, ball-radial construction. Write for your free copy today.



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All types of ball and roller bearings — 4" inside diameter to 178" outside diameter . . . Taper Roller Roller Thrust • Roller Radial • Needle Roller • Ball Radial • Ball Thrust • Four-Point Contact Bearings

Circle 213 on Page 19

trends

engineering/personal

NSPE's Solution to Engineering Education Problems

U. S. engineering education is deficient in two distinct areas—graduate work and technician education programs—according to Paul H. Robbins, executive director of the National Society of Professional Engineers. Testifying before a Senate education subcommittee, Mr. Robbins said that NSPE favors the granting of postgraduate scholarships and fellowships, rather than undergraduate scholarships, as proposed by the Administration. Referring to the second need, Mr. Robbins pointed out the fact that judicious use of trained technicians for routine tasks greatly increases "professional-level output" of engineers.

Industrial Design for Engineers

The British Council of Industrial Designers is offering design appreciation courses for engineers. The working engineers' course consists of two sets of lectures—before and after a "homework" period. Practicing industrial designers discuss the students' projects and make recommendations for further training. A separate, short course for engineering managers covers development of industrial design, influence of color and form, and human factors.

materials

New Synthetic May Give a Tire Two Lives

Thirty-five per cent more mileage and, perhaps, an eventual doubling of tread life, are foreseen by the Goodyear Tire & Rubber Co. for tires made with its new Budene, a cis-polybutadiene rubber. In laboratory tests and 3 million miles of road tests, Budene tires have shown improved carcass durability, lower operating temperatures, and markedly improved tread wear. Test tire shown (driven over 15,000 miles under heavy load) has Budene tread on the upper half, conventional synthetic rubber on the lower half.

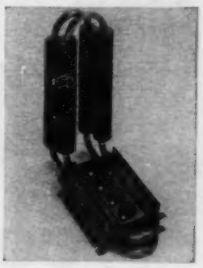
EPOXY RESIN-SILICONE RUBBER compound has adhesive properties of epoxy and resiliency of rubber. Emerson & Cuming Inc., Canton, Ohio, developer, describes it as the permanetly plasticized, high-temperature epoxy. Designated Eccosil 4712, it is supplied as a two-part, free-flowing material. Viscosity is 60,000 centipoises. In the cured state, it can be used at 450 F continuously, at higher temperatures for intermittent periods.

SAPPHIRE WHISKERS reinforce silver to produce a machinable metal that doesn't lose its strength at very high temperatures. The composite has been tested at 118,500 psi—five times stronger than pure silver. It was made at GE's Missile and Space Vehicle Dept. by causing molten silver to infiltrate a pack of sapphire whiskers in a vacuum.

INCREASE IN TENSILE STRENGTHS at cryogenic temperatures is reported for the 5000-series aluminum-magnesium alloys. Data, prepared for the Aluminum Association by Battelle Memorial Institute, do not reveal a transition from ductile-to-brittle behavior in welded and unwelded samples as temperatures are lowered to −423 F (liquid hydrogen). Sharp-notched strength is also greater at −423 than at room temperature.

COMPOSITION OF THE SURFACE of a dilute metallic alloy is significantly different from the bulk of the material beneath the surface. This discovery was made by Dr. Joseph T. Kummer of Ford Motor Co. He found that oxidized surfaces of dilute copper-nickel alloy samples were 90 parts copper to 10 parts nickel, while the bulk retained a 99 to 1 ratio.

Liquid Cooling for Electronics



Dissipation of heat generated by transistors and diodes is accomplished with a cooling liquid in the thermal syphon, developed by Inland Certified Electronics, Pasadena, Calif. This method is more efficient than air-cooling, according to Inland. Syphons are available in any length and are constructed so that they can be stacked, assuring compact installation. Heat-exchanger tubing can be supplied for still greater dissipation of heat.

MATERIALS, NOT COMPONENTS will be the major factor in electronic technology during the next decade, according to Dr. D. E. Noble, Motorola's executive vice president. "The trend is toward the use of exquisitely refined materials with molecular control." Sophisticated solid-state circuits, based on materials research, will be used in everything from computers to TV. Their most important characteristic: Reliability.

ARTIFICIAL NEURON, in the form of a four-transistor circuit, has simulated the essential characteristics of human neurons, according to two RCA researchers. T. B. Martin and F. L. Putzrath described an electronic model of a biological hearing apparatus at the recent Second Annual Bionics Conference. They said the electronic neuron reproduced human analog, digital, and temporal characteristics.

Ten-Year Plan for Army Aircraft

Changes programmed by the Army for combat-area aircraft by 1970 include: Reduction of the number of helicopter and fixed-wing models from eleven to six, conversion from piston to turbine engines, and standardization of fuels used by all Army aircraft. Of the six replacement aircraft, three are now operational, two are in the test-flight stage, and one is in the planning stage. Several will have interchangeable parts, and engines of two will be interchangeable. Pictured is the Hummingbird, a VTOL to be built by Lockheed.

Upper Stage for Saturn Spacecraft

NASA has awarded a contract (estimated at $140 million) to the Space and Information Systems Div., North American Aviation Inc., to develop an upper stage for an advanced Saturn launch vehicle, to be used in both manned and unmanned missions. The new stage, using four liquid oxygen-hydrogen engines, will deliver a total thrust of 800,000 lb. Mounted on a new first stage powered by two 1.5-million-pound-thrust engines, it will be able to place a 40-ton spacecraft in a 300-mile orbit.

COATING PLASTIC OR GLASS substrates with conductive and/or light-transmissive thin films is possible with a technique announced by Halex Inc., El Segundo, Calif. Previously only relatively soft or low-melting substances could be applied to Mylar or glass substrates; the new high-vacuum process deposits platinum, tantalum, niobium, and nichrome with minimum fractional distillation.

A THERMOELECTRIC GENERATOR furnishes the power necessary to prevent self-corrosion of the steel casing of a Texas gas well. Located between the well and a ground bed of silicon cast iron anodes, the generator reverses flow of current set up by the casing as it reacts electrochemically with the soil. The ground bed corrodes instead of the casing. Westinghouse built the generator, which burns gas from the well.

the '62 cars

Buick Electra 225

Buick Special Deluxe Convertible

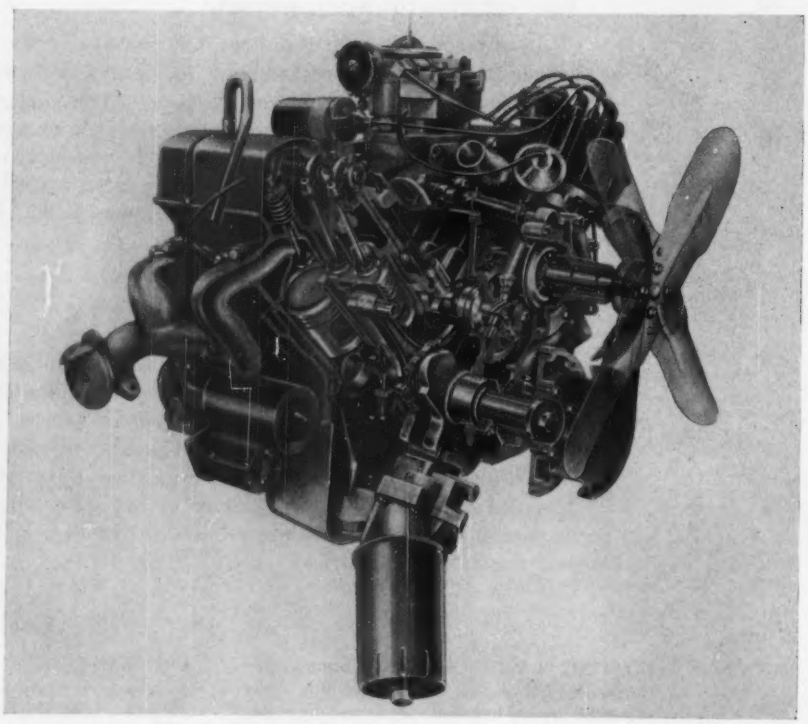
buick and special . . .

THE first V-6 in a contemporary U. S. automobile will be the standard powerplant in Buick's bottom-of-the-line Special. Displacing 198 cu in., the new engine weighs from 140 to 179 lb less than comparable in-line sixes. It also beats current in-line engines in power output in the usable speed range between 25 and 80 mph.

In highway passing tests (50 to 80 mph) staged by Buick, the V-6 outperformed GM's 215-cu in. V-8 and two competitive in-line sixes by a margin of about 40 per cent. The 215-cu in. engine, with several power options available, will again be the standard powerplant in the Special-Deluxe and Skylark series.

Following an industry trend, Buick has added convertible models in the Special and Special-Deluxe series. Optional items for all models include a positive-traction differential and four-speed gearbox with floor-mounted shift lever.

Buick's full-size cars—LeSabre, Invicta, Electra—have been facelifted; basic dimensions are relatively unchanged. Last year's 364-cu in. engine in LeSabre has been abandoned, and all Buicks now share the 401 cu in. engine in various states of carburetion and compression ratio.



Buick's V-6: Unusually high performance is claimed for the engine. One reason can well be its sizeable 198-cu in. displacement. Another, as described by Buick, rests on technical ground: Engine-firing sequence alternates from bank to bank, and symmetrical firing impulses produce a significant ram effect in the simple log-type, two-barrel intake manifold. Uniform gas pulses also provide a scavenging effect in each exhaust manifold. End result: Power output is enhanced, for better acceleration.

Circle 20-1 on Page 19 for extra copy.

Chevrolet Impala Sport Coupe

Chevy II Station Wagon

Corvair 700 4-Door Sedan

chevrolet, corvair, and chevy II . . .

MAJOR mechanical change in the full-size Chevrolet is a new 327-cu in. V-8 which replaces last year's 348-cu in. powerplant. Performance of the 327 reportedly equals that of the 348, which has been relegated to heavy-truck duty.

A redesigned (more aluminum) Powerglide transmission, weighing 85 lb less than last year's, is available for use with the new engine. Turboglide is discontinued, and the '62 chassis is basically a carry over.

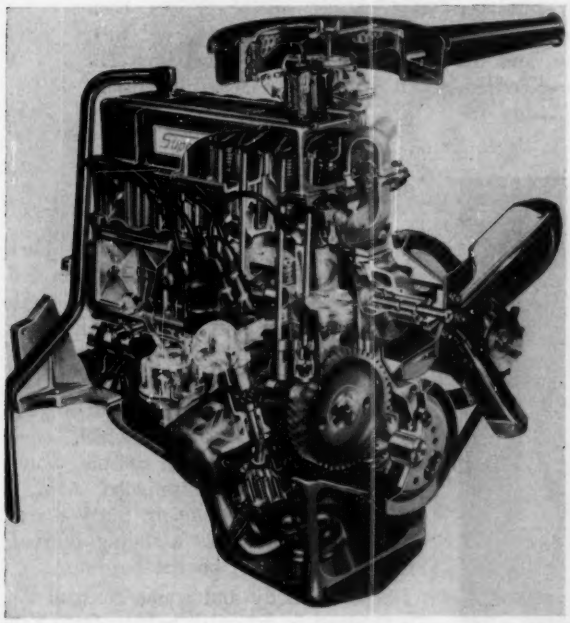
Chevy II, a new series for '62, has been shoehorned between Chevrolet and Corvair. Nine Chevy II models are segregated into three series—100, 300, Nova—with station wagons listed in each. Two and four-door sedans are included in the 100 and 300 series; Nova has a sport coupe and convertible.

Mechanically, Chevy II boasts two innovations: A brand new in-line four-cylinder engine, the first for Chevrolet since 1928, and the much heralded single-leaf (tapered beam) rear spring.

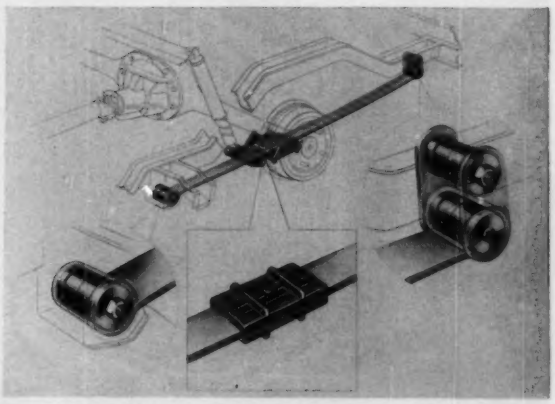
An important manufacturing development is wrapped up in the new spring, providing a maximum stress level in the spring 25 per cent higher than in multi-leaf assemblies. The high stress level and fatigue requirements are satisfied through an exceptional shot-peening process. The spring's upper surface, and only this surface, is shot peened under tension to the equivalent of several inches of jounce. Fatigue properties are increased up to ten times those acquired through unstressed shot peening, the method commonly used in multi-leaf fabrication.

Integral body-frame construction in Chevy II consists of two basic substructures (unitized front end, body proper) rigidly bolted together. Front fenders also bolt on.

Corvair for '62 is relatively unchanged.



Chevy's in-line four is not a radically designed engine, but relies on conventional carburetion, electrical, lubrication, and cooling systems for reliability and simplicity. Refined casting techniques have minimized weight of the cast-iron engine; five main bearings, more than adequate in a four, insure rigidity and smoothness of operation. Displacement is 153 cu in.; maximum power output, 90 hp @ 4000 rpm.



Single-leaf rear spring in Chevy II varies in thickness and width over its entire length. From a relatively deep section at the axle center, thickness diminishes toward each end. The reverse occurs in the plan view, with the width at axle center smaller than at the ends. Stress distribution is thus uniform, and the spring is said to be ideal for Chevy's conventional Hotchkiss-type rear suspension.

polara and lancer . . .

Dodge Polara 500 Convertible

Lancer Grand Turismo

IN LINE with the industry's bucket-seat trend, Dodge is introducing a sports model in each series. The Polara 500 and Lancer Grand Turismo fill this category in Dodge's full-size and compact lines, respectively.

Optional performance powerplant in the Lancer GT is the 225-cu in. aluminum-block six which delivers a minimum of 145 hp. Weight of the engine is 45 lb less than the standard Lancer 170-cu in. (101 hp) cast-iron six. Its performance is said to equal that of many V-8s.

Standard engine in the Polara 500 is a 361-cu in. V-8, rated at 305 hp. It comes with manual three-speed or automatic transmission.

Both the 500 and GT boast a number of mechanical refinements, most of which appear this year in all Chrysler cars. Chassis-lubrication fittings have been removed from all points on front-suspension ball joints, steering-linkage connections, and clutch-torque-shaft bushings. Ten fittings, in all, are prelubricated at the factory, with no further servicing recommended for 32,000 miles.

Lancer's manual gear-shift lever has been moved from the floor to the steering column, and the steering mechanism is of recirculating-ball design, replacing the tooth-to-tooth cam-sliding mechanism used in '61 models.

Polara's wheelbase has been cut 6 in. (116 in. vs. 122 in.), over-all length is down from 212 to 202 in. Lancer's dimensions are unchanged.

Studebaker Lark 2-Door Sedan

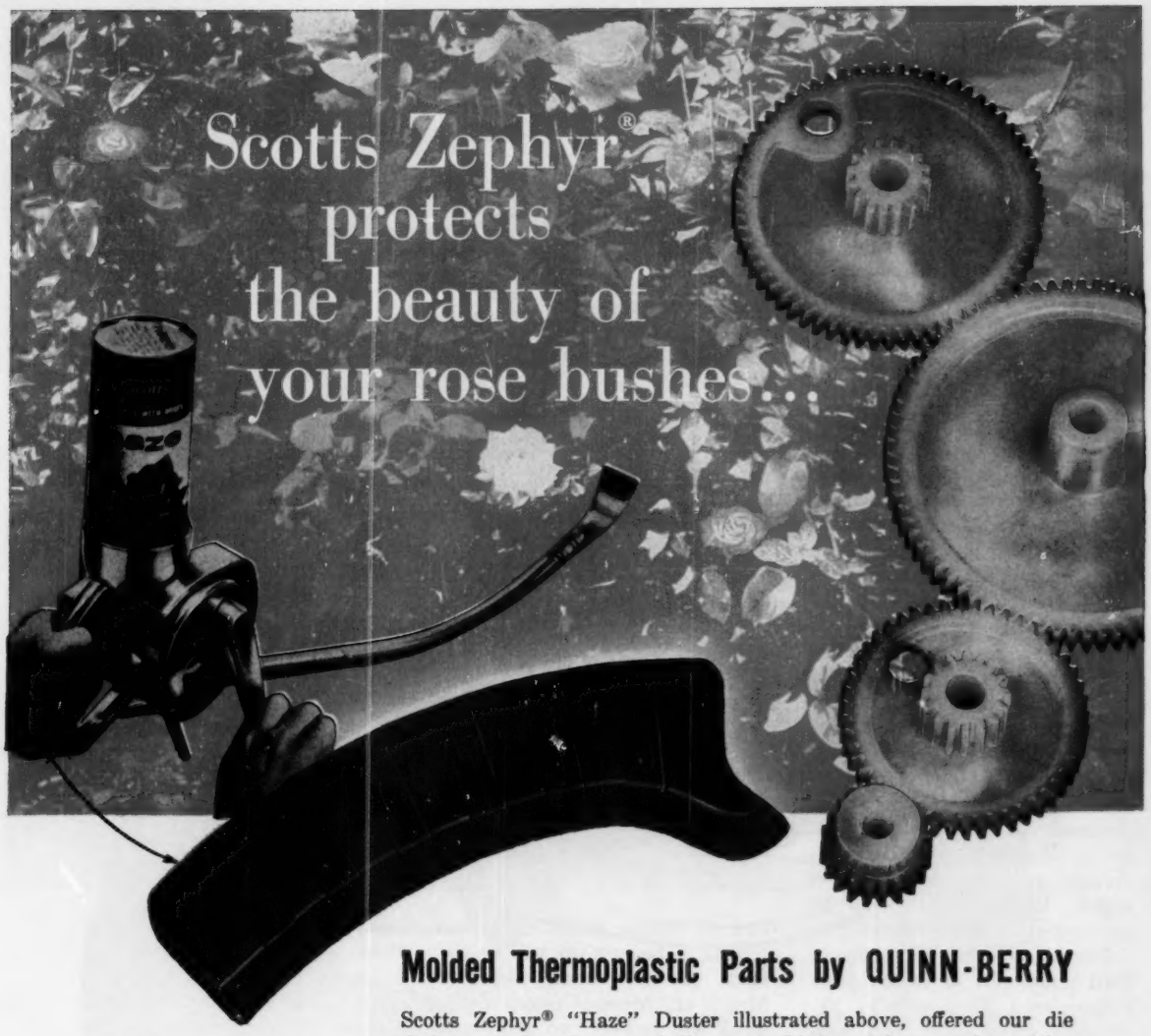
studebaker lark . . .

ONE of the original compacts, Lark has reversed the field this year and lengthened all models. Over-all length has been increased 9 to 13 in., wheelbase has been stretched 4.5 in. Net effect is a longer, lower look.

Lark's entry in the bucket-seat brigade is the new Daytona model, which comes complete with front-seat console. Four-speed, floor-shift transmission with a straight lever is optional in the V-8 version. Also optional is a sliding sunroof, which can be had on the hardtop.

Separate body and frame construction is retained in '62, with bolt-on front and rear fenders. The grille section also bolts into place. Heavier gage steel used in the frame provides a 30-per cent increase in strength.

Engine line-up for '62 is essentially unchanged.



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Circle 214 on Page 19

the '62 cars

mercury and comet . . .

MERCURY, like Chevrolet, has brought out an intermediate model that fits between Comet and the full-size Mercury Monterey. Called the Meteor, the new car will be built on a 116.5-in. wheelbase—2.5 in. longer than Comet, 3.5 in. shorter than Monterey.

Standard engine in the Meteor is Comet's 170 cu in. six, with a new 221-cu in. V-8 optionally available. Performance increase with the V-8 is noticeable: It weighs just 75 lb (23 per cent) more than the six, but adds 42 hp (41 per cent more power). Exceedingly compact (20 in. over exhaust manifold), the new engine is relatively straightforward in design. One unusual detail: Valve rocker arms are individually mounted, eliminating the long rocker-arm shaft. Hydraulic lifters are used. Three-speed synchromesh transmission is standard in all models, overdrive is optionally available with the V-8 engine. Engine speed is cut 30 per cent with the overdrive.

Meteor follows the current Ford philosophy of twice-a-year-maintenance. This includes 30,000-mile major lubrication, self-adjusting brakes, two-year radiator coolant, 30,000-mile fuel filter, and oil change at 6000-mile intervals. The new car will be offered in two series: Mercury Meteor and Meteor Custom. Each series will include two and four-door sedans.

Full size Mercury's are relatively unchanged for '62, other than styling and accessory refinements. Comet is also a carry-over, with several additional models and luxury options. No convertible has been added to the line.

Mercury Monterey Custom 4-Door Hardtop

Mercury Comet Custom 2-Door Sedan

rambler american . . .

AN automatic clutch, called "E-Stick," is one of the major engineering changes in '62 Ramblers. Optional on all models, E-Stick is shifted like a standard transmission, minus the use of a clutch pedal. Internally, a conventional disc and pressure plate are engaged by levers, no thrust springs or centrifugal weights are used. A pneumatic-hydraulic system (engine oil pressure and intake-manifold vacuum) activates the mechanism.

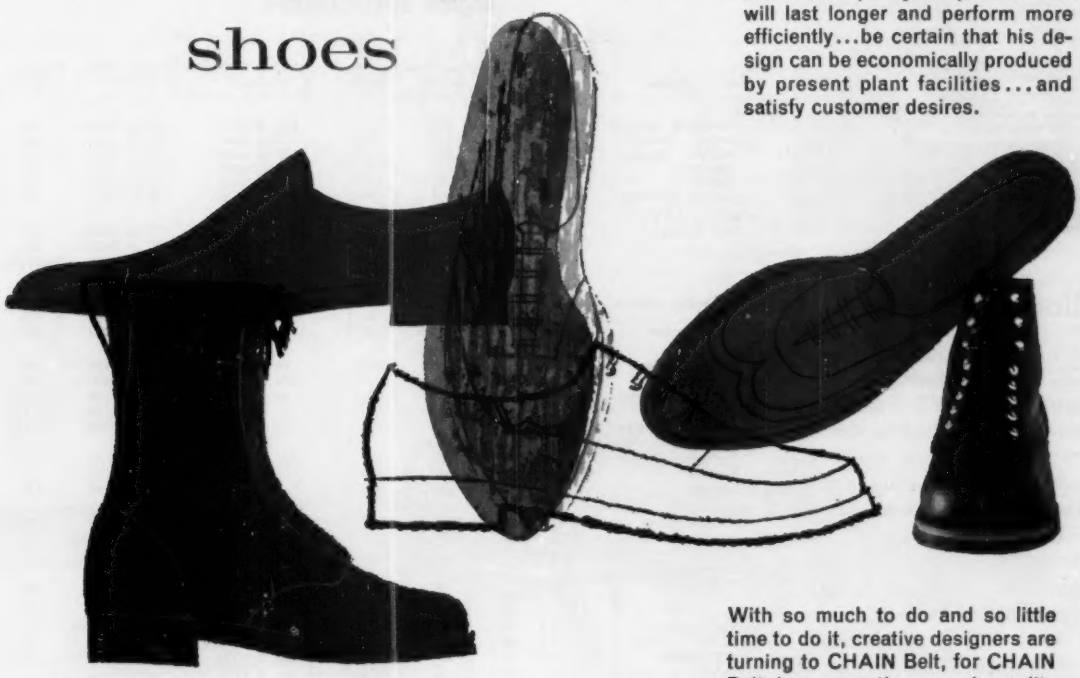
Also new is a dual-braking system, offered as standard equipment on all American models. It uses a tandem master cylinder to provide a separate hydraulic system for the front and rear pairs of wheels.

Front suspension and steering-linkage lubrication will be extended from 1000 to 2000 miles in '62; normal drain period for engine oil is now 4000 miles. Two-year radiator coolant is optional.

Rambler, like many other '62 models, will be equipped with "four-ply rated" two-ply tires.

TO THE CREATIVE DESIGNER...

how many shoes must you fill?



Today the design engineer must be more than a competent designer! He must wear the shoes of top management, purchasing, production, sales, service *and* the customer.

He must design for lower cost, higher profit...include more sales features...specify components that will last longer and perform more efficiently...be certain that his design can be economically produced by present plant facilities...and satisfy customer desires.

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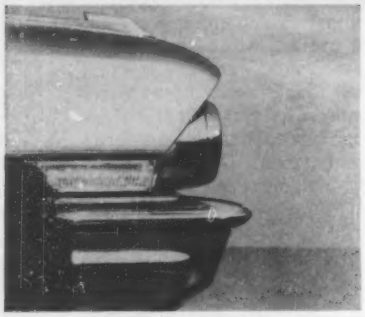
Circle 215 on Page 19

Cadillac Convertible



cadillac . . .

MOST of Cadillac's design changes for 1962 were made to enhance safety. Heading the list is a new braking system which incorporates a dual power-brake master cylinder with separate piston and fluid reservoir for front and rear wheels. In normal operation, the system functions as an integrated unit. However, if one of the hydraulic lines fails or is damaged, one pair of wheel brakes would still be operative. Cadillac's parking brake, which again this year is a true auxiliary brake, provides a third means of stopping if all else fails.

A new cornering light, the first for many years in the industry, is another Cadillac safety feature. Mounted on the side of the fender, ahead of the front wheel (picture, above), the light is activated by the turn-signal lever when the headlights, parking lights, or foglamps are on. The steady cornering beam angles out 40 degrees from the side of the headlamp, lighting the driver's way into a turn at night.

Cadillac's basic dimensions and engine specifications are unchanged for '62. Following an industry trend, the 500-mile initial oil change has been eliminated, with the first change now set at 4000 miles.

Engine Specifications

Make & Model	Bore & Stroke (in.)	Displacement (cu in.)	Compression Ratio	Power, max (bhp)	Torque, max (lb-ft)	Carburetion
BUICK						
Standard Special	3.63 x 3.20	198*	8.8:1	135 @ 4600	205 @ 2400	2b
Deluxe Special	3.50 x 2.80	215	9.0:1	155 @ 4600	220 @ 2400	2b
Skylark Special	3.50 x 2.80	215	11.0:1	190 @ 4800	235 @ 2800	4b
LeSabre	4.19 x 3.64	401	10.25:1	280 @ 4400	424 @ 2400	2b
Option	4.19 x 3.64	401	9.0:1	265 @ 4400	412 @ 2400	2b
Invicta, Electra	4.19 x 3.64	401	10.25:1	325 @ 4400	445 @ 2800	4b
CHEVROLET						
V-8 options	3.87 x 3.00	283	8.5:1	170 @ 4200	275 @ 2200	2b
	4.00 x 3.25	327	10.5:1	250 @ 4400	350 @ 2800	4b
	4.00 x 3.25	327	10.5:1	300 @ 5000	360 @ 3200	large 4b
	4.31 x 3.50	409	11.0:1	380 @ 5800	420 @ 3200	4b
	4.31 x 3.50	409	11.0:1	409 @ 6000	420 @ 4000	2—4b
Corvette options	4.00 x 3.25	327	11.25:1	340 @ 6000	344 @ 4000	large 4b
	4.00 x 3.25	327	11.25:1	360 @ 6000	352 @ 4000	FI
Six cylinder	3.56 x 3.94	235.5	8.25:1	135 @ 4000	217 @ 2200	1b
CHEVY II						
Four cylinder	3.88 x 3.25	153	8.5:1	90 @ 4000	152 @ 2400	1b
Six cylinder	3.56 x 3.25	194	8.5:1	120 @ 4400	177 @ 2400	1b
CORVAIR (6 cyl)	3.44 x 2.60	145	8.0:1	80 @ 4400	128 @ 2300	2—1b
Monza option	3.44 x 2.60	145	9.0:1	84 @ 4400	130 @ 2300	2—1b
All-model option	3.44 x 2.60	145	9.0:1	102 @ 4400	134 @ 3000	2—1b
DODGE						
Polara	4.12 x 3.38	361	9.0:1	305 @ 4800	395 @ 3000	4b
Lancer	3.40 x 3.13	170	8.2:1	101 @ 4400	155 @ 2400	1b
Option	3.40 x 4.13	225	8.2:1	145 @ 4000	215 @ 2800	1b
RAMBLER						
American (6 cyl)	3.13 x 4.25	195.6	8.0:1	90 @ 3800	160 @ 1600	1b
Option	3.13 x 4.25	195.6	8.7:1	125 @ 4200	180 @ 1600	1b
MERCURY						
Monterey						
V-8 options	4.05 x 3.78	390	9.6:1	300 @ 4600	427 @ 2800	4b
	4.00 x 3.50	352	8.9:1	220 @ 4300	336 @ 2600	2b
	3.75 x 3.30	292	8.8:1	170 @ 4200	279 @ 2200	2b
Six cylinder	3.62 x 3.60	223	8.4:1	138 @ 4200	203 @ 2200	1b
Meteor (6 cyl)	3.50 x 2.94	170	8.7:1	101 @ 4400	156 @ 2400	1b
V-8 option	3.50 x 2.87	221	8.5:1	143 @ 4500	217 @ 2200	2b
COMET (6 cyl)	3.50 x 2.50	144	8.7:1	85 @ 4200	134 @ 2000	1b
Six-cyl option	3.50 x 2.94	170	8.7:1	101 @ 4400	156 @ 2400	1b
LARK						
Six cylinder	3.00 x 4.00	170	8.25:1	112 @ 4500	154 @ 2000	1b
Cruiser V-8	3.56 x 3.25	259	8.5:1	180 @ 4500	260 @ 2800	2b
Cruiser options	3.56 x 3.25	259	8.5:1	195 @ 4500	265 @ 3000	4b
	3.56 x 3.62	289	8.5:1	210 @ 4500	300 @ 2800	2b
	3.56 x 3.62	289	8.5:1	225 @ 4500	305 @ 3000	4b
CADILLAC	4.00 x 3.88	390	10.5:1	325 @ 4800	430 @ 3100	4b

*V-6 engine

Body Dimensions

Make & Model	Wheelbase (in.)	Length (in.)	Width (in.)	Height (in.)	Tread F/R (in.)
BUICK					
Special	112	188.4	71.3	52.8	56 — 56
LeSabre, Invicta	123	214.1	78	56.3	62 — 61
Electra	126	220.1	78	57	62 — 61
CHEVROLET	119	209.6	79	55	60.3 — 59.3
Corvette	102	176.7	70.4	52.1	57 — 59
CHEVY II	110	183	70.8	55	56.8 — 56.3
CORVAIR	108	180	67	51.5	54.5 — 54.5
DODGE					
Polara	116	202	75.6	54	59.4 — 57.5
Lancer	106.5	184.2	70.4	53.4	55.9 — 55.6
RAMBLER	100	173.1	70	56.1	54.6 — 55
MERCURY					
Monterey	120	215.5	79.5	54.9	61 — 60
Meteor	116.5	203.8	71.3	56.1	57 — 56
COMET	114	194.8	70.4	54.5	55.0 — 54.5
LARK	113	188	71.4	56.5	57.4 — 56.6
CADILLAC	129.5	222	79.9	56.3	———

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ALEMITE OIL MIST WITH THERMO-AIRE® GUARDS ITS GIANT BEARING!

The FPS-35 radar at Montauk Air Force Station, designed and developed by Sperry Gyroscope Company, is one of the largest in the world. The huge 140,000-pound antenna assembly rides on a precision-built azimuth bearing with an outside diameter of 160.500-inches. This bearing is machined to fit its retainer with a total looseness of no more than 0.006 of an inch.

10-years of continuous operation, with only four 24-hour shutdowns a year for servicing maintenance, is the life design-requirement for this antenna. For the all-important job of lubricating this azimuth bearing, Sperry Engineers selected Alemite Oil-Mist with Thermo-Aire. Oil-Mist provides the *fully-automatic, continuous, all-over* lubrication protection this bearing positively requires for trouble-free operation.

Oil-Mist with the new, exclusive Thermo-Aire enables Sperry's Engineers to eliminate guesswork lubrication assuring greater efficiency . . . longer bearing life. Oil-Mist is extra-clean; does away with drippings. Thermo-Aire permits atomization of the heaviest mineral oils and applies them automatically and continuously.

Find out how Alemite Oil-Mist can protect many of your designs against wear and breakdown. Write for free Oil-Mist catalog, or see your Alemite representative.

Symbol of SW Excellence

ALEMITE DIVISION
STEWART-WARNER CORPORATION

In Canada: Stewart-Warner Corporation of Canada Ltd., Belleville, Ontario

Dept. BB-91, 1850 Diversey Parkway, Chicago 14, Illinois

Circle 216 on Page 19

Triple-threat transporter can be driven at 45 to 50 mph on the road, cross rough terrain as easily as a tracked vehicle, and travel in water at 5 knots. It carries a 5-ton load and can tow an additional 10 tons. Called the Stalwart, the vehicle is built by Alvis Ltd., Coventry, England. It is powered by a 220-hp Rolls-Royce engine. All six wheels are independently suspended, sprung on torsion bars and damped by hydraulic shock absorbers.

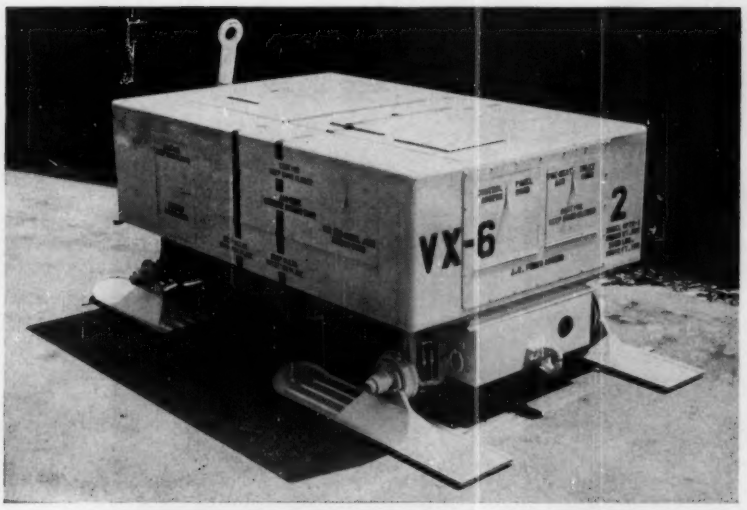
Plastic sandwiches in a new refrigerated freight car make possible the maintenance of any temperature from −10 to 70 F. The three-layer panels which line the car are made of Cycolac polymer, a rigid ABS plastic produced by Marbon Chemical Div. of Borg-Warner Corp.; Dylite expandable polystyrene insulation, by Koppers Co.; and a ¼-in. plywood back. These panels reduce weight of the refrigerator car and, because they are only 6½ in. thick, add 451 cu ft of space to the car's capacity.

Fifty words in three seconds is the teletype speed record set by Bell System's new Data speed units. The punched tape sender (left) and the receiver can handle 1050 words a minute, which is ten times as fast as present exchange teletypewriter tape transmission equipment. The Data-Phones can also be used over ordinary telephone lines at regular rates.

ENGINEERING NEWS

PICTURE REPORT

Slenderest delta has a wing-span of only 20 ft; sweep of the plane's leading edge is greater than that of any other aircraft. It is Handley-Page's H.P. 115, a supersonic research plane which recently made its first half-hour test flight. In subsequent flights, handling characteristics and stability and control at low speeds necessary during take-off, approach, and landing will be studied.

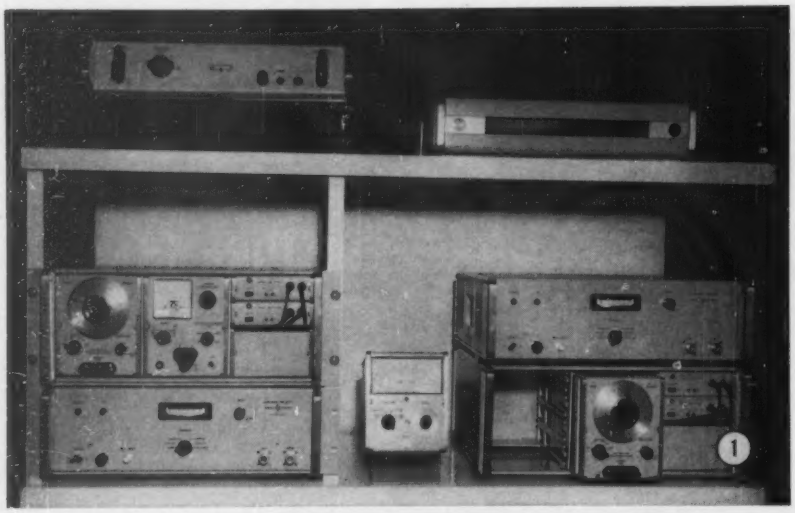


Power on skis checks out and starts jet aircraft based in the Antarctic. Able to operate at −100 F, this power sled generates ac and dc electric power for checkout and pneumatic power for starting. It is built by the AiResearch Div. of the Garrett Corp., Los Angeles.

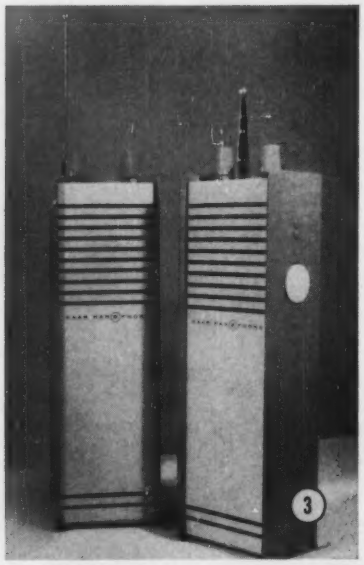
Ceramic thermoelectric generator can operate at temperatures up to 2400 F and produces 1000 to 1200 mu v per deg C. This is four times the voltage of thermoelectric generators made of more commonly used materials such as intermetallics, according to Minneapolis-Honeywell, which developed the generator for the Army. Each of the generator's 14 layers is sprayed with nickel oxide (a ceramic) on one side and platinum on the other, then scored so that it appears to be wrapped with a wire. Felt-like ceramic separates the layers, and even assembly nuts and bolts are ceramic. This generator provides a means of producing electricity from the heat of rocket exhaust and, perhaps, from heat generated by re-entry.

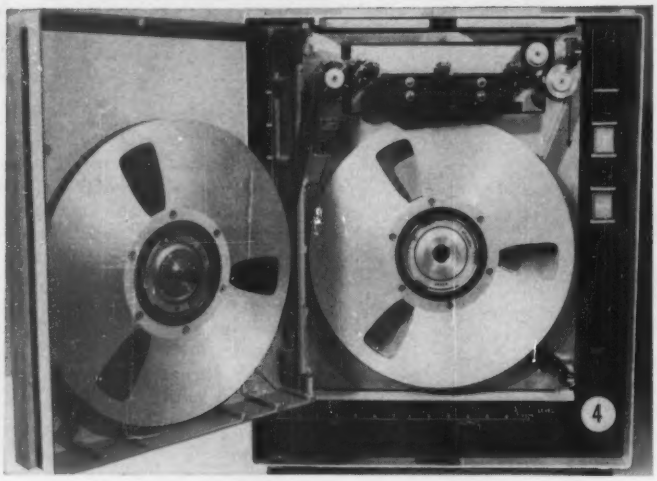
Industrial Design

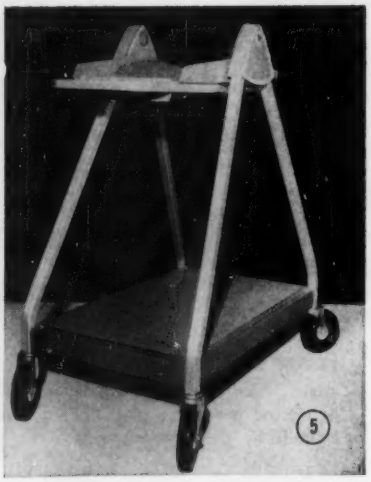
comments and configurations

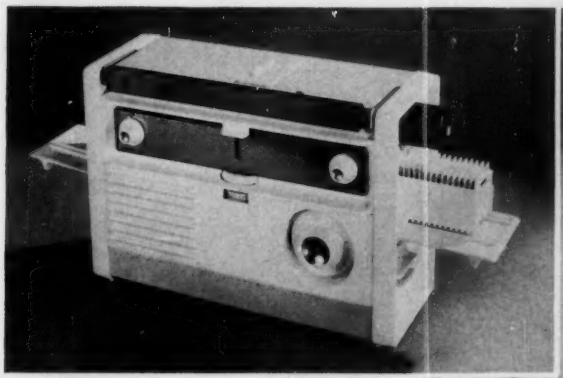


Five winners in industrial design competition at the recent Wescon Show were selected from 140 entries. Top award went to Hewlett-Packard Co., Palo Alto, Calif., for its electronic enclosure system design—a family of packaging modules for related electronic instruments (1). Certificates of excellence were given to Collins Radio Co., Cedar Rapids, Iowa, for its FM transmitter (2); Kaar Engineering Corp., Palo Alto, for its hand-phone transmitter-receiver (3); Precision Instruments Inc., San Carlos, Calif., for its magnetic-tape recorder-reproducer (4); and Tektronix Inc., Portland, for its Scopemobile (5); used to move oscilloscopes in the laboratory.



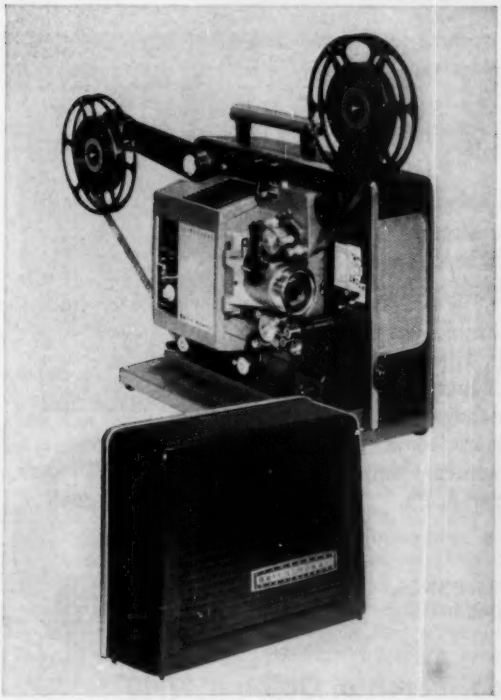




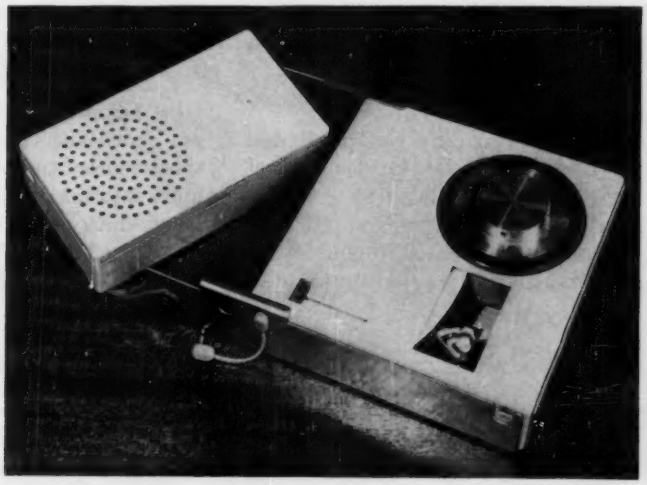


Carrying handle, turned to the side, becomes the operating lever that advances slides in Sears Roebuck's new Tower slide projector. There is also a three-way editor that permits loading trays while projecting, previewing single slides, and rearranging slides during showing. The projector's housing and other components are of American Cyanamid's Beetle urea plastic; molder is G-M Laboratories Inc.

Bell & Howell's model 535 Filmsound, with magnesium castings, miniaturized electrical components, and a fiber glass case, weighs 29 lb—8½ lb less than previous B & H 16-mm projectors. Intense light projects a sharp picture in a room that has not been completely darkened, and sound will reach an audience of 500 without auxiliary speakers.



Combination transistor radio and record player in a 10 by 6 by 1½ in. polystyrene case won the award for best plastics product in the Design Display at Interplas (International Plastics Exhibition) held in London. Designer is Max Braun, Frankfurt on Main, Germany.



think about TEXIN™

Gears formed of Texin urethane elastomer by fast, low-cost injection molding methods give you mass production economy with consistent uniformity of dimensions without machining.

Texin is particularly recommended for the design of gears for silent, vibration- and maintenance-free transmissions having low torque and pitch circle speeds, such as office equipment, automated household appliances, automotive gear boxes and gear-actuated power units for aircraft and industrial equipment where long-wearing reliability is a critical requirement.

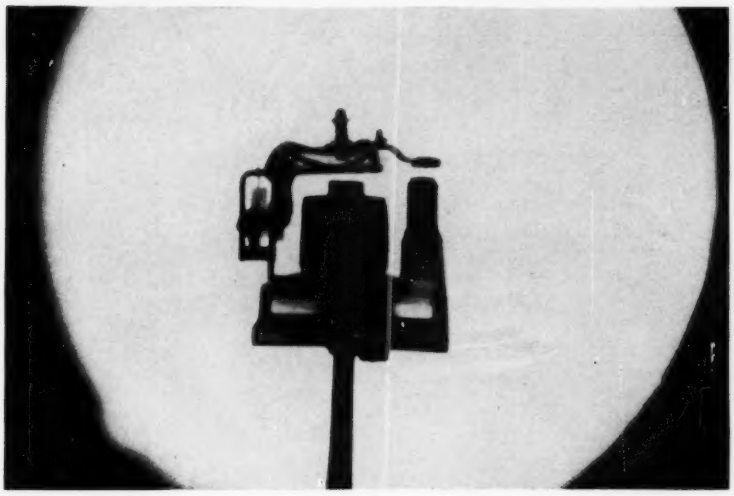
Now Texin lets you mold gears that are shock-absorbing, silent running, shatter-proof and self-lubricating. For more information on how to put this heavy-duty elastoplastic to work for you, write Mobay Chemical Company, Code MC-8, Pittsburgh 5, Pa.

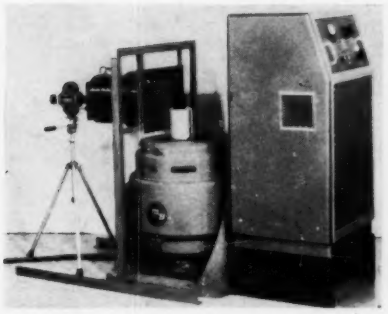
To keep posted on new application developments for Texin, ask to be placed on the TEXIN TOPICS mailing list . . .

MOBAY

e-9

SPACE A-24 Plastics Show of Canada, Toronto, October 17-19





Pulsed x-ray image of a relay is sharp even though the relay is undergoing vibration tests and is completely enclosed within an electronic package (left). Prototype model of the system (right) includes a camera to record test results, x-ray image intensifier, and x-ray source.

Pulsed X-Rays Picture Boxed-In Troubles

NEW HAVEN, CONN.—Moving parts that are totally enclosed in an opaque box can now be monitored during vibration tests. Unblurred photographs are obtained by a new rapid-pulsing x-ray technique developed by Zenith Radio Research Corp. In addition to "watching" the actions of hidden relays, switches, etc., the technique can be used to stop action inside engines and other mechanical equipment.

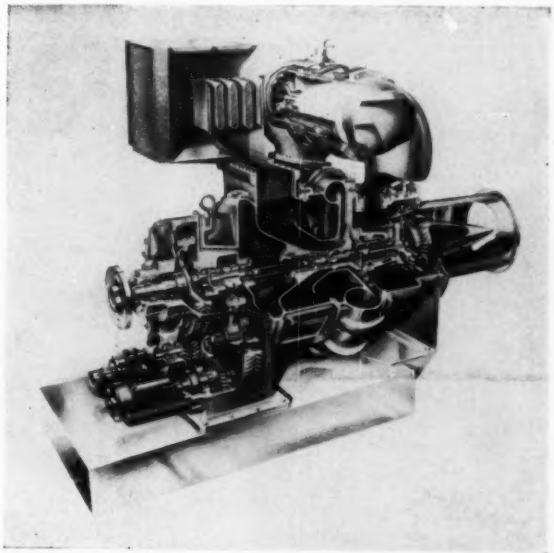
The multiple-pulse x-ray system has created a new dimension in environmental testing, according to Galt B. Booth, technical director, MB Electronics, division of Textron Electronics Inc. (MB has acquired marketing rights to the system). Hidden components have been difficult or impossible to observe during vibration tests because continuous x-ray sources cannot project sufficient energy through an object in a short enough time to eliminate blur. The Zenith system capitalizes on the fact that vibration studies do not require continuous sequences of pictures. By shutting off the x-ray source between exposures, Zenith engineers have been able to keep the tube-target cool. The cool target allows intensity of the x-ray beam to be increased to a level that penetrates test specimens and produces the necessary film density in one mu sec.

The tube fires 30 times per sec, allowing vibration studies to be conducted over a wide frequency and velocity range. Results are permanently recorded on film, and the number of exposures can be regulated to suit test requirements.

Application of the technique to any specific piece of equipment depends on thickness and density of the housing, but the potential range of applications is quite broad, according to MB. Small electronic components are particularly well suited —they present few handling problems. Most large items can also be easily adapted for testing.

Step Toward a Truck Turbine?

Gas-turbine powerplants may soon get their chance on British vehicles. British Motors Corp. claims its new Austin-250, designed for industrial uses, is an important step toward a truck engine. Lightweight, simple, and robust, it resulted from 12 years of research on compressors, turbines themselves, heat exchangers, and combustion chambers. During this time, the only published facts concerning the unit had to do with a turbine-driven car which served as a mobile test bed. The powerplant develops 250 bhp, weighs only 900 lb, and is extremely reliable, BMC spokesmen continue, and the company is undertaking further research on the problems of matching the A-250 to a truck. The industrial model is a single-shaft machine in which the turbine drives the centrifugal compressor at 29,000 rpm. Pressure ratio is 3.5:1, and power is taken from the rotor assembly, through a two-step reduction gear using double helical gears for long life. The output speed is reduced to 1500 rpm for 50-cycle electricity generation, but the unit could be supplied for any required speed. It measures 37 in. long x 35 in. wide x 51 in. high.



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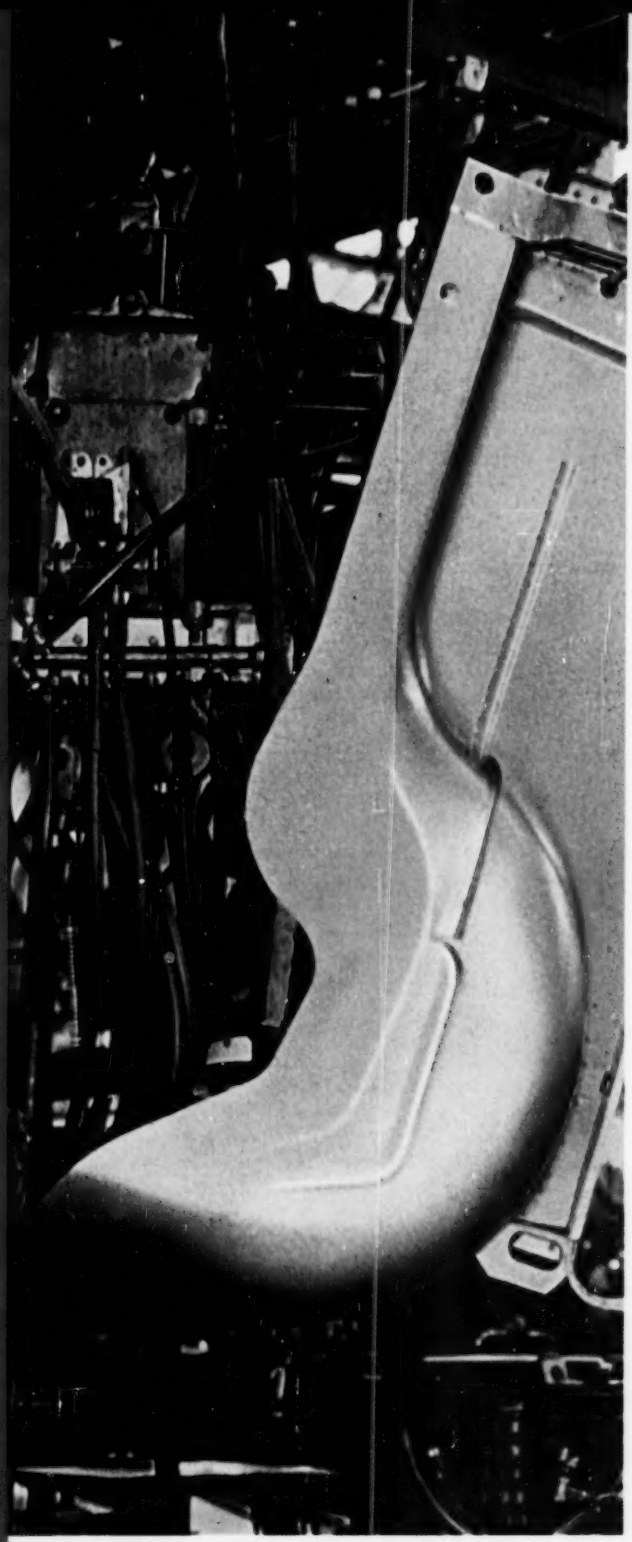


DRAW

New Youngstown rolling and annealing capacity means ready availability of higher quality sheet steel

New sheet steel from Youngstown thrives in an atmosphere all its own. In 50 new stack annealing furnaces, Youngstown sheet takes on the exact grain structure and degree of plasticity you need for forming. You get the precise working characteristics required for mild or deep drawing quality.

Quality control in annealing is only a part of Youngstown's sheet story. A modernized 79″ hot strip mill with electronic testing devices and automatic gauge control equipment assures you of more uniform quality steel sheet. This giant mill rolls huge 38,000 pound coils, delivers fewer welds, reduces your coil "down time." Prior to annealing, cold tandem mills reduce thickness to strict tolerances and give the sheet its exacting finish.

Order new Youngstown sheet in widths from 24″ to 72″. Use it in mild and deep draws. Work with it. You'll find it delivers all the qualities you need. Specify Youngstown sheet from 28 Youngstown District Offices or from your nearby Steel Service Center. Specify Youngstown's new annealing process. Specify softness. Or tempered hardness. You can depend on getting precisely what you want, when you choose Youngstown sheet.

Youngstown – growing force in steel

For full details on Youngstown sheet and annealing write: Dept. 11-D,
The Youngstown Sheet and Tube Company, Youngstown, Ohio

Circle 219 on Page 19

Meetings and Shows

Oct. 9-11—
National Electronics Conference to be held at the International Amphitheatre, Chicago. Additional information is available from conference headquarters, 228 N. La Salle St., Chicago 1, Ill.

Oct. 9-13—
Society of Automotive Engineers Inc. National Aerospace Engineering and Manufacturing Meeting, including engineering display, to be held at the Ambassador Hotel, Los Angeles. Further information can be obtained from SAE, 485 Lexington Ave., New York 17, N. Y.

Oct. 9-15—
American Rocket Society. Sixteenth Annual Meeting and Space Flight Report to the Nation to be held at the Coliseum, New York. Additional information can be obtained from society headquarters, 500 Fifth Ave., New York 36, N. Y.

Oct. 10-12—
American Standards Association. Twelfth National Conference on Standards to be held at the Rice Hotel, Houston. Further information is available from ASA headquarters, 10 E. 40th St., New York 16, N. Y.

Oct. 15-19—
Technical Association of the Pulp and Paper Industry. Engineering Conference to be held at the Shoreham Hotel, Washington, D. C. Additional information is available from J. Winchester, 360 Lexington Ave., New York, N. Y.

Oct. 16-18—
American Institute of Electrical Engineers. 12th Annual Machine Tools Industry Conference to be held at the Faust Hotel, Rockford, Ill. Additional information is available from the conference chairman, N. P. Bashor, W. F. and John Barnes Co., 301 S. Water St., Rockford, Ill.

Oct. 17-18—
American Society of Mechanical Engineers. Materials Handling Conference to be held at the Pick Nicolette Hotel, Minneapolis, Minn. Further information can be obtained from Meetings Dept., ASME, 345 E. 47th St., New York 17, N. Y.

Oct. 17-19—
Plastics Show of Canada to be held in the Automotive Bldg., Canadian National Exposition Grounds, Toronto, Ontario. Further information can be obtained from William Pryde, 481 University Avenue, Toronto 2, Ontario, Canada.

Oct. 17-19—
American Society of Mechanical Engineers—American Society of Lubrication Engineers. Joint Lubrication Conference to be held at the Morrison Hotel, Chicago. Further information is available from Meetings Dept., ASME, 345 E. 47th St., New York 17, N. Y.

Oct. 18-20—
Gray Iron Founders' Society. Annual Meeting to be held at the Royal York Hotel, Toronto, Canada. Additional information is available from society headquarters, National City-E. 6th Bldg., Cleveland 14, Ohio.

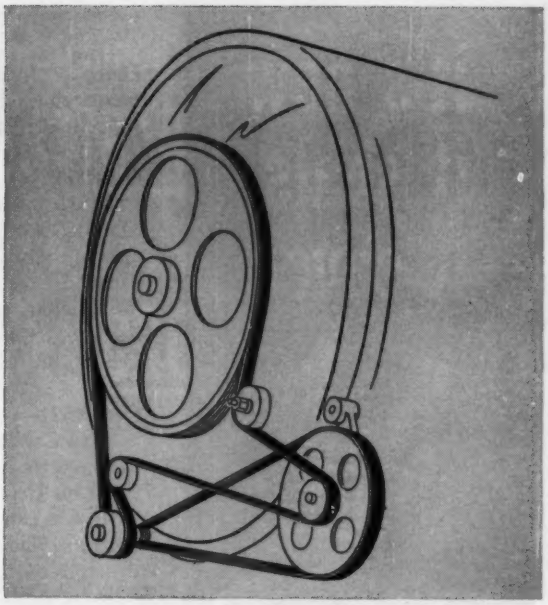
Oct. 19-20—
National Conference on Industrial Hydraulics to be held at the Sherman Hotel, Chicago. Additional information is available from Illinois Institute of Technology, 35 W. 33rd St., Technology Center, Chicago 16, Ill.

Oct. 19-20—
American Society for Quality Control. 16th Midwest Conference to be held at the Chase-Park Plaza Hotel, St. Louis. Additional information is available from Alan W. Peterson, Century Electric Co., P. O. Box 187, St. Louis 66, Mo.

Oct. 19-21—
National Society of Professional Engineers. Fall Meeting to be held at the Hotel Roanoke, Roanoke, Va. Further information can be obtained from NSPE, 2029 K St., N.W., Washington 6, D. C.

Oct. 23-27—
American Society for Metals. 43rd National Metal Congress and Exposition to be held at Cobo Hall,

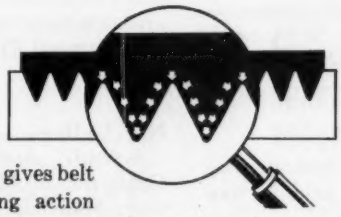
DAYTON POLY-V® Drives pack more power in smaller spaces



Offer engineers greater versatility in drive design

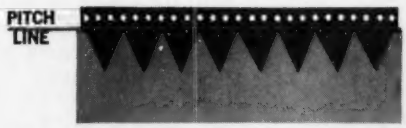
Dayton Poly-V Drives are *single* units. They run in sheaves designed to mate perfectly with belt ribs. This provides twice the tractive surface per inch of sheave width . . . *up to 50% more power in ⅔ the space.* Result —a more compact, lighter drive . . . less shaft overhang.

Greater horsepower capacity



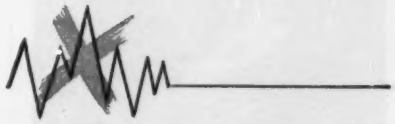
Full contact design gives belt ribs greater gripping action in sheave grooves. Belt tension is transferred equally and in all directions through the belt ribs to the sheave groove walls (hydrostatic principle).

Uniform speed ratios



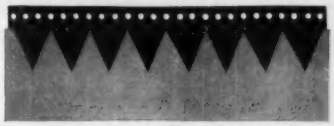
Full contact design distributes the load equally over the entire contour of the V-ribs. Peak loads cannot cause the Poly-V belt to ride lower in the sheave grooves. Pitch diameters and speed ratios remain constant from no load to full load condition.

Vibration free



Full contact design guarantees smooth, vibration-free operation. Full molded surface has complete contact with the sheaves. Poly-V belts have uniform belt thickness—no slipping . . . no creeping.

Greater flexibility



Reduced belt thickness means smaller sheave diameters (as small as ¾" with "J" belts)—less centrifugal force. This permits operations at higher belt speeds (up to 10,000 FPM for Poly-V "J")—ideal for high speed motors.

Simplified drive design

Only 3 Poly-V cross sections are required:

"J"—from fractional to 10 HP
"L"—for intermediate drives (5 to 50 HP)
"M"—for high HP drives (25 HP and up)

See your Dayton engineer

Let Dayton's Engineering Service help you with your drive design. Call or write:

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Dayco CORPORATION

Dayton Industrial Products Co. Div. Melrose Park, Illinois

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it's new
it seals
it saves

it's DELRIN*

Another RB&W development from Delrin plastic, this new threaded plug replaces more expensive metal plugs in many hydraulic and compressor applications.

It not only saves on cost and weight, but also does a better job. Fluid pressure forces mating threads together, creates a still tighter seal, locks threads in place.

Metal-like mechanical properties of Delrin provide excellent strength, dimensional stability, rigidity. Count also on resistance to corrosion and solvents.

Available in ⅛, ¼, ⅜, ½" pipe sizes. Send for samples.

Ask about other parts you would like custom-molded from Delrin, or other thermoplastics, in production quantities.

Write Russell, Burdsall & Ward Bolt and Nut Company, Port Chester, New York.

*Du Pont trademark

R B & W
117th year

Circle 221 on Page 19

Detroit. Further information can be obtained from ASM headquarters, Metals Park, Novelty, Ohio.

Oct. 26-27—

American Society of Tool and Manufacturing Engineers. Semi-annual Meeting to be held in Toronto, Canada. Additional information is available from society headquarters, 10700 Puritan Ave., Detroit 38, Mich.

Oct. 29-31—

Fluid Controls Institute Inc. Fall Meeting to be held at the Hotel Hershey, Hershey, Pa. Further information can be obtained from the institute, P. O. Box 667, Pompano Beach, Fla.

Nov. 1-3—

Society for Experimental Stress Analysis. First International Congress on Experimental Mechanics to be held at the Hotel New Yorker, New York. Papers will cover experimental stress analysis and other areas of experimental mechanics, and there will be a display of latest equipment and instrumentation used in the field. Additional information can be obtained from SESA headquarters, 21 Bridge Square, Westport, Conn.

Nov. 6-10—

American Nuclear Society. Annual Meeting, to be held in conjunction with the Atomic Industrial Forum, AtomFair, and the National Youth Conference on the Atom at the Conrad Hilton Hotel, Chicago. Additional information can be obtained from society headquarters, 86 E. Randolph St., Chicago 1, Ill.

"A minute and twelve seconds Smurthwaite! Is that more important than our entire missile program?"

Nov. 7-10—

Packaging Machinery Manufacturers Institute Show to be held at Cobo Hall, Detroit. The Conference-Workshop will be held Nov. 8 and 9. Further information is available from the show manager, Shea Expositions Corp., 1 Gateway Center, Pittsburgh 22, Pa.

Nov. 9-10—

Society of Automotive Engineers Inc. Fuels and Lubricants Meeting to be held at the Shamrock Hotel, Houston, Texas. Further information can be obtained from SAE headquarters, 485 Lexington Ave., New York 17, N. Y.

Nov. 13-15—

Steel Founders' Society of America. Technical and Operating Conference to be held at the Hotel Carter, Cleveland. Additional information is available from society headquarters, 606 Terminal Tower, Cleveland 13, Ohio.

Nov. 13-16—

Seventh Annual International Conference on Magnetism and Magnetic Materials to be held at the Westward Ho Hotel, Phoenix. Sponsors are American Institute of Electrical Engineers and American Institute of Physics, in co-operation with the Office of Naval Research, Institute of Radio Engineers, and Metallurgical Society of the AIME. Further information is available from Dr. P. B. Myers, Motorola Inc., 5005 E. McDowell Rd., Phoenix 8, Ariz.

Nov. 15-17—

Aerospace Electrical Society. Annual Display to be held at the Pan Pacific Auditorium, Los Angeles. Additional information is available from Norman Lynn, 1830 W. Olympic Blvd., Los Angeles 6, Calif.

Nov. 26-Dec. 1—

American Society of Mechanical Engineers. Winter Annual Meeting

to be held at the Statler Hilton Hotel, New York. Additional information can be obtained from Meetings Dept., ASME, 345 E. 47th St., New York 17, N. Y.

Short Courses and Symposia

Oct. 10-11—

Seminar on Manufacturing with Space-Age Metals, sponsored by the American Society of Tool and Manufacturing Engineers, to be held at the Sheraton Hotel, Philadelphia. Further information is available from Gilbert E. Seeley, Education Director, ASTME Headquarters, 10700 Puritan Ave., Detroit 38, Mich.

Oct. 11—

Fall Symposium of the Institute of Printed Circuits, to be held at the Sheraton-Chicago Hotel, Chicago, will be devoted to discussion of molecular electronics. The program is aimed at management, as well as technical, personnel. Additional information is available from Institute of Printed Circuits, 27 E. Monroe, Chicago 3, Ill.

Oct. 12-13—

Seminar on Thermoset Plastics to be held at the University of Wisconsin. Further information is available from Engineering Institutes, 3030 Stadium, University of Wisconsin, Madison 6, Wis.

Oct. 25-26—

Computer Applications Symposium, sponsored by Armour Research Foundation, to be held at the Morrison Hotel, Chicago. User experience in computer application and programming techniques will be emphasized. Additional information is available from Benjamin Mittman, program chairman, Armour Research Foundation, 10 W. 35th St., Chicago 16, Ill.

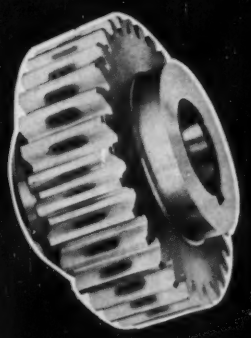
Oct. 26-27—

Seminar on Effective Drafting Management to be held at the University of Wisconsin. Further information is available from Engineering Institutes, 3030 Stadium,

(*Please turn to Page 46*)

Give your machines the advantages of

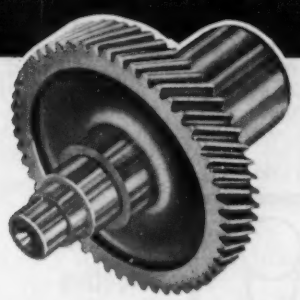
SELF-ALIGNING GEARS!



Sier-Bath

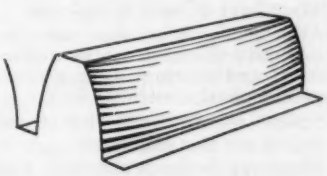
CROWN-GROUND

CASE-HARDENED SPUR and HELICAL GEARS



Similar in function to Self-Aligning Bearings, *Sier-Bath's* CROWN-GROUND GEARS Eliminate the damaging effects of

— MISALIGNMENT
— SHAFT DEFLECTION
— TOOTH DISTORTION



What is Crown-Grinding? As perfected by Sier-Bath gear specialists, the horizontal section and vertical profile of the gear tooth face is modified by Grinding *after Hardening* so that the CROWN-GROUND teeth are thinner at the ends than the center and the involute profile is simultaneously relieved in accordance with the requirements of each particular application. Tooth action is concentrated over the crowned central area where strength is greatest. Destructive "End Bearing" is eliminated while extreme quietness and a smoothly uniform tooth action are maintained even under severest misalignment, deflection, loads and speeds.

Because Sier-Bath crown-grinds *after hardening,* heat-treatment distortions are entirely eliminated. Hence the "Crown" can be attained in materials of 38 Rc and harder while simultaneously maintaining required tooth accuracies. Install Sier-Bath Crown-Ground spur and helical gears in your machinery for greater design latitude—greater productiveness and longer life for your equipment.

COST NO MORE!

IF YOU ARE USING GROUND TOOTH GEARS, these Sier-Bath Crown-Ground gears cost the same as, and often less than, commercially-made ground tooth gears.

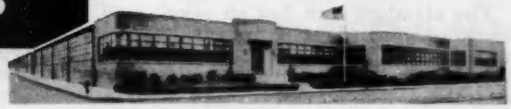
Send details or print of your application—or request a Sier-Bath gear engineer to explain the vast improvements possible in your machines by using Crown-Ground case-hardened gears. Write on your Company letterhead for literature regarding Sier-Bath's "Gears of Tomorrow".

Sier-Bath GEAR & PUMP CO., Inc.
9237 Hudson Blvd., North Bergen, N. J.

Sier-Bath PRECISION GEARS

Also manufacturers of Rotary Pumps and Flexible Gear Couplings

Founded 1905 Members A.G.M.A.



Circle 222 on Page 19

(Advertisement)

Control your speed with Century's complete line of Selective Speed Drives

We're often asked why Century offers six different basic types of selective speed drives. The answer is simple—what is ideal for one type of application may be completely unsuitable for another. No one, two, or three lines—no matter how complete each of them is—can match every application that requires easily adjustable speed. That's why Century offers the most complete lines available to industry.

But with several separate and distinct lines, the choice of which type to use for a particular application sometimes appears complicated. To take some of the mystery out of controlled speed drive selection, we've described the six various types we manufacture below. See which one fits your needs best:

Mechanical Selective Speed Drives

Type:
Constant-torque variable horsepower

Horsepower range:
½ Hp to 30 Hp

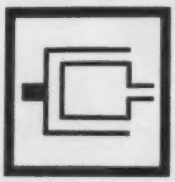
Speed ranges:
2:1, 3:1, 4:1, 5:1, 6:1, 8:1

The Century type MD Drive is simple, inexpensive and compact, and can be controlled either manually or automatically. It utilizes a standard Century motor, a variable pitch belt drive transmission, and a gear reduction unit when low speeds are required. Other than standard squirrel cage, normal torque motors can be furnished where required.

Type MD units incorporate a Century-designed cooling system that extends belt life and permits increased load factors. Drive and driven pulleys are constantly aligned to automatically correct belt tension. Design simplicity is such that modifications can easily be made in the field, such as changing from "horizontal" to "upright" mounting, moving the control to different positions, or changing drive motors.

The standard unit has an easy-operating handwheel with built-in indicator for speed control. Mechanical, electric remote and pneumatic control can also be easily adapted.

Typical mechanical drive applications are packaging and labeling machines, conveyors, pumps, agitators, textile machines, plastic extruders, testing equipment, canning machines, printing presses, etc.



Magnetic Coupling Selective Speed Drives

Type:
Constant- or variable-torque

Horsepower:
Constant-torque 1 through 500 Hp; variable-torque 1 through 1000 Hp

Speed ranges:
8:1 standard

The type MC Century magnetic coupling drive consists basically of a squirrel-cage induction motor and a magnetic coupling connected to the output shaft. There is no mechanical connection between the driving and driven members of the unit; torque is transmitted by magnetic flux. Output speed is controlled by regulating the excitation to the magnet member of the clutch.

Several reasons have contributed to the increasing use of magnetic coupling drives:

1. They have a lower initial cost.
2. All-electric, they are easy to maintain. Circuits can be understood and serviced by any competent plant electrician.
3. Space requirements for these drives are at a minimum.
4. Speed regulation is excellent, due to tachometer feedback control. Plus or minus 2% maximum speed regulation with load changes from 25% to 100% full load is standard.

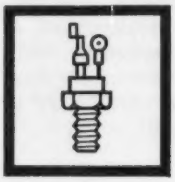
Constant-torque MC drives have several definite minimum operating speeds listed for continuous duty. With variable-torque units, there is no minimum operating speed due to nature of loading. Drives may be equipped to operate at inching or jogging speeds for setup purposes, or at very low speeds on an intermittent basis. Control may also be manual or automatic, as a function of temperature, pressure flow, or almost any other controlling factor.

Three types of Century Magnetic Coupling Drives are built:

Form A Drives are constructed with the AC drive motor and magnetic coupling as an integral unit. They can be mounted with the drive shaft either horizontal or vertical. Typical uses for these units are for such constant-torque loads as conveyors, slitters, printing presses, coaters, laminators, etc.; and variable-torque loads of centrifugal pumps, fans and compressors.

Form B Drives have the AC drive motor and magnetic coupling assembled on a common bedplate and are furnished as a complete unit. Applications of this unit for constant-torque or variable-torque loads are similar to the Form A unit.

Form C Drives are furnished as separate units, with AC drive motor and magnetic coupling furnished as individual units for final coupling or belting by the customer to suit specific job needs.



Controlled Rectifier Selective Speed Drives

Type output:
Constant-torque

Horsepower:
Half-wave—1/12 to 1 Hp
Full-wave—1/12 to 15 Hp

Speed ranges:
75:1 standard

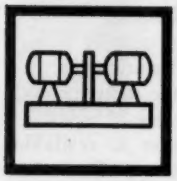
These units utilize silicon-controlled rectifiers with special patented triggering circuits. They are completely static and eliminate use of electronic tubes. Each complete set consists of a packaged static type power unit; DC drive motor, and an operator's station. Drive motors may be furnished with almost any mechanical modifications.

Some of the outstanding advantages of controlled rectifier drives are these:

1. No warm-up time is required before starting up.
2. Tube flashover and arcing is eliminated.
3. There are no relays to service.
4. Speed regulation is close.
5. The improved wave-form factor resulting from the use of silicon rectifiers permits the use of a smaller drive motor than equivalent electronic drives.

6. Complete short circuit and overload protection is provided.
7. In many cases, mechanical modifications are less expensive than with equivalent electronic drives.

Typical applications of Century type CRF and CRH controlled rectifier drives include: blue print machines, conveyors, printing presses, welding positioners, etc.



Motor-Generator Set Selective Speed Drives

Type output:
Constant-torque, minimum to base speed; constant-horsepower above base speed.

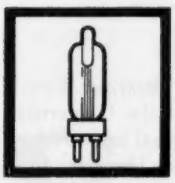
Horsepower range:
1 through 500 Hp

Speed ranges:
Almost any required ranges available.

Century type MGE and MGM Motor-Generator Sets are packaged selective speed drives that provide all the versatility of direct current adjustable voltage systems. Advantages of these units include wide speed range for continuous operation, exact speed control under any loading condition, and either single or multi-motor drives.

Complete unit consists of a packaged-type power unit with power-conversion equipment and controls; a DC adjustable drive motor, and operator's control station. Drive motors may be furnished in any desired enclosure or with almost any mechanical modifications.

Typical applications for Century type MGE and MGM Motor-Generator Sets include: paper rewinders, paper slitters, steel slitters, tube mills, brick presses, plastic extruders, textile ranges, wallboard applications, etc.



Electronic Type Selective Speed Drives

Type output:
Constant-torque

Horsepower ranges:
1/20 to 30 Hp

Speed ranges:
Up to 100:1

Three types of Century Electronic Drives are available. Type TH is a half-wave rectifier unit, designed for lower horsepower ranges, 1/20 to ¾ Hp. Type TF, full-wave rectification, is intended for applications from ¾ to 4 Hp. Type TA, also full-wave rectification, is built in sizes from ¾ to 30 Hp.

Type TH Electronic Drives provide the following advantages in lower horsepower ranges:

1. Wide speed range. (20:1 standard, 50:1 available)
2. Close speed regulation — ±3% of base speed maximum.
3. Reasonable initial cost.
4. Simplified maintenance.
5. Stepless speed control over the unit's entire range.
6. Extremely smooth acceleration.
7. Dynamic braking available.
8. Operating speed can be preset.

Typical applications for Type TH Electronic Drives include: packaging machinery, small printing presses, conveyors, machine tool feeds, trimming machines, etc.

Type TF bridge-type adjustable voltage electronic drives provide operation over a wide speed range (8:1 standard; as high as 100:1 available for light loads and intermittent duty) at the same time it furnishes close speed regulation (plus or minus 3% of base speed).

Smooth acceleration is one of the important advantages of this equipment. This protects the connected machinery and work-in-process from shocks and damage due to rapid acceleration. Tube circuits are designed to "fail safe," eliminating the danger of motor runaways in the event of failure.

Typical uses for Type TF drives include: paper machines, machine tools, textile machines, small conveyors, bagging machines, and other applications where good speed regulation over a wide range is important.

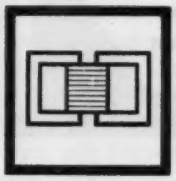
Type TA Electronic Speed Drives are ideal for applications that require extremely wide speed range with close speed regulation. Standard factory adjustment is for a 50:1 speed range. 100:1 may be furnished for special intermittent applications.

Speed regulation can be set "flat" for any speed and when this is done, regulation for any other speed will be within 2% of base speed, with 80% load change, and within 1 to 2% of base speed with line voltage fluctuation of plus or minus 10%.

Since acceleration is under constant current, smooth start-up is inherent in the drive. Starting current may be easily adjusted from 50% to 200% of full-load current.

Dynamic braking is standard. Dynamic slow-down and reversing can also be supplied as options.

Type TA Drives find wide use driving machine tools, processing equipment, conveyor lines, precision welding positioners, etc.



Magnetic Amplifier Selective Speed Drives

Type output:
Constant-torque

Horsepower range:
1 through 200 Hp

Speed range:
8:1

Century Type SA Magnetic Amplifier drives replace electron tubes and circuits with power magnetic amplifiers and static silicon rectifiers for trouble-free and maintenance-free operation. The unit is packaged and completely prewired.

Some of the important advantages of these units are as follows:

1. 5% speed regulation from 20% to 100% load.
2. Complete overload and rectifier protection.
3. Timed acceleration (2-30 Hp) and current limit acceleration (40-200 Hp) prevents electrical or mechanical overloads when changing speeds.

These drives are highly useful in applications where speed regulation is not extremely critical, such as: printers slotters, printing presses, plastic extruders, etc.

In a host of industries, Century Selective Speed Drives have improved quality, increased production, reduced scrap and waste, lowered maintenance costs, made production schedules more flexible, cut downtime and unit costs, or created other benefits. And there's a good chance that they can improve *your* product or process.

Want to know more? Century has prepared a new 246-page Controlled Speed Catalog with specifications, prices, modifications and dimensions on all six basic types of Century Selective Speed Drives. We'll send you a copy if you'll request it on your letterhead. Or call your nearby Century Sales Engineer for recommendations on the drive that's just right for *your* job. 61-1

CENTURY ELECTRIC COMPANY

St. Louis 66, Missouri *Offices and Stock Points in Principal Cities*

WHEN SPACE IS LIMITED AND WEIGHT IS A FACTOR

A NEW MAC LEAN-FOGG LOCKING FASTENER

WHIZ-LOCK FLANGETTE

SMALLER !

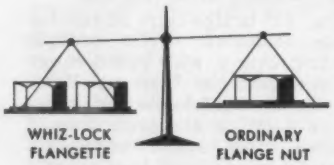
The new M-F Flangette Lock Nut is much smaller than ordinary flange nuts, yet is structurally strong, locks dependably, simplifies assembly.

No. 10 FLANGETTE

No. 10 FLANGE NUT

LIGHTER !

Keep weight down with the M-F Flangette. The tiny flange strengthens the entire nut . . . permits lighter body. Weight: considerably less than the conventional flange nut of equivalent size.

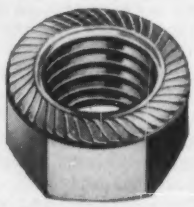


WHIZ-LOCK FLANGETTE

ORDINARY FLANGE NUT

SAFE, SURE LOCK !

The "Flangette" utilizes the patented MacLean-Fogg Whiz-Lock principle. Spins on—locks to the surface on which it bears. Easiest of all lock nuts to apply. Withstands shock and vibration.



WHIZ-LOCK FLANGETTE UTILIZES M-F PATENTED WHIZ-LOCK LOCKING PRINCIPLE

AVAILABLE IN 4 SIZES: No. 6, No. 8, No. 10, 1/4"

SAMPLES ON REQUEST

MAC LEAN-FOGG M-F LOCK NUTS

MacLean-Fogg Lock Nut Company

5535 N. WOLCOTT AVENUE

CHICAGO 40, ILLINOIS

(Continued from Page 43)

University of Wisconsin, Madison 6, Wis.

Oct. 28—

First National Symposium of the Industrial Designers Institute to be held at the Somerset Hotel, Boston. Theme of the symposium is "The Pivoting Forces"; its aim is to explore, in part, the relationship between the work of the designer and the needs of the forces of freedom. Additional information is available from E. Betty Berry, Executive Secretary, Industrial Designers Institute, 441 Madison Ave., New York 22, N. Y.

Oct. 29-31—

International Symposium on Photoelasticity to be held at the Illinois Institute of Technology. Sponsors are IIT, four government and military groups, and five technical societies. Twenty papers will be presented on topics including photoelasticity, photoplasticity, photothermalelasticity, dynamic photoelasticity, and special equipment. Additional data can be obtained from M. M. Frocht, Research Professor of Mechanics, Illinois Institute of Technology, Chicago 16, Ill.

Nov. 3-4—

Tenth Annual Instrumentation Conference to be held at Louisiana Polytechnic Institute. Developments in the field of instrumentation and its applications to process control will be covered. Further information can be obtained from School of Engineering, Louisiana Polytechnic Institute, P. O. Box 255, Tech Station, Ruston, La.

Nov. 6-17—

Short Course on Bearing Technology to be held at the University of California. Additional information is available from Sam Houston, Engineering Extension, Room 6266 Engineering Bldg. II, University of California, Los Angeles 24, Calif.

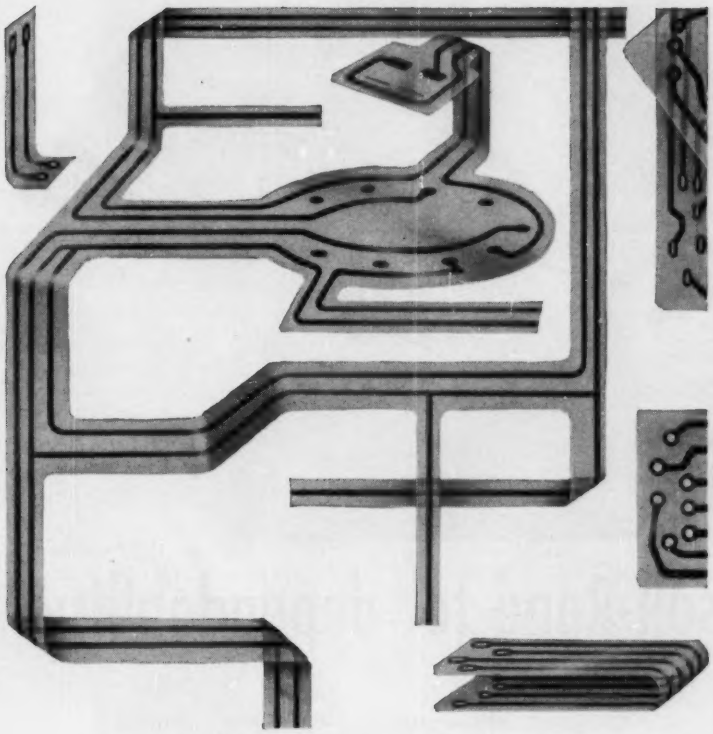
Nov. 13-16—

Research Symposium on Electrical Contacts to be held at Pennsylvania State University. Additional information is available from Conference Center, Pennsylvania State University, University Park, Pa.

Circle 224 on Page 19

NEW FLEXIBLE PRINTED CIRCUITRY

from Garlock



Garlock flexible printed circuitry can be economically induction soldered due to high temperature resistance of Teflon FEP.

Teflon FEP*—and its outstanding electrical, physical and thermal properties—has been incorporated by Garlock into an advanced circuit design that offers many distinct advantages over conventional wiring or rigid printed wiring boards.

Greater design freedom. Garlock Flexible Printed Circuitry can be bent or twisted into any desired shape to allow design freedom without compromise to overall reliability. It can be designed to conform exactly to package contours and component parts. Garlock offers terminations adaptable to common industry standards.

Maximum reliability. Garlock Flexible Printed Circuitry is made of etched copper completely encapsulated between two layers of Teflon FEP. Permanently bonded under pressure, this encapsulation affords both line-to-line and line-to-ground protection, and will resist penetration of harmful moisture and gases. No adhesive is used to effect the bond, eliminating any possibility of breakdown through aging.

Reduced size and weight. Garlock Flexible Printed Circuitry can often cut overall package dimensions by as much as 50%. Being extremely flexible, it will hug curves, go around corners, conform to the most eccentric layout. And, because of excellent electrical properties a thinner gauge of Teflon FEP can handle the same job that requires thick gauges of other insulating materials. This, combined with the use of less copper, greatly reduces package weight.

For more information, call your nearest Garlock Electronic Products representative for more data, or write Garlock Electronic Products, Garlock Inc., Camden 1, New Jersey.

GARLOCK

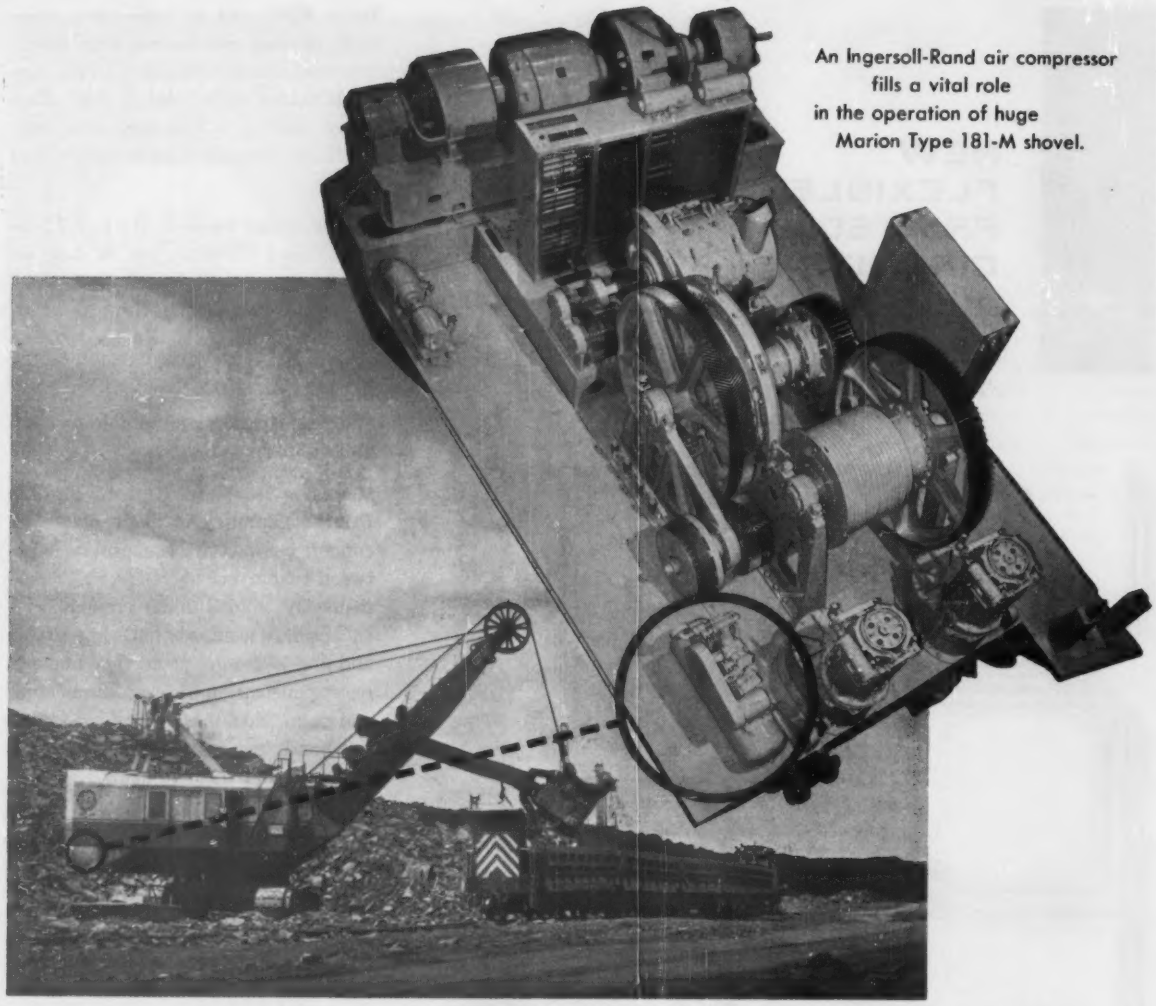
ELECTRONIC PRODUCTS

Canadian Div.: Garlock of Canada Ltd.

Plastics Div.: United States Gasket Company.

Order from the Garlock 2,000 . . . two thousand different styles of Packings, Gaskets, Seals, Molded and Extruded Rubber, Plastic Products.

*DuPont Trademark



An Ingersoll-Rand air compressor fills a vital role in the operation of huge Marion Type 181-M shovel.

design with Ingersoll-Rand for dependability

Get complete details from your Ingersoll-Rand representative or write for catalog data.

147A3

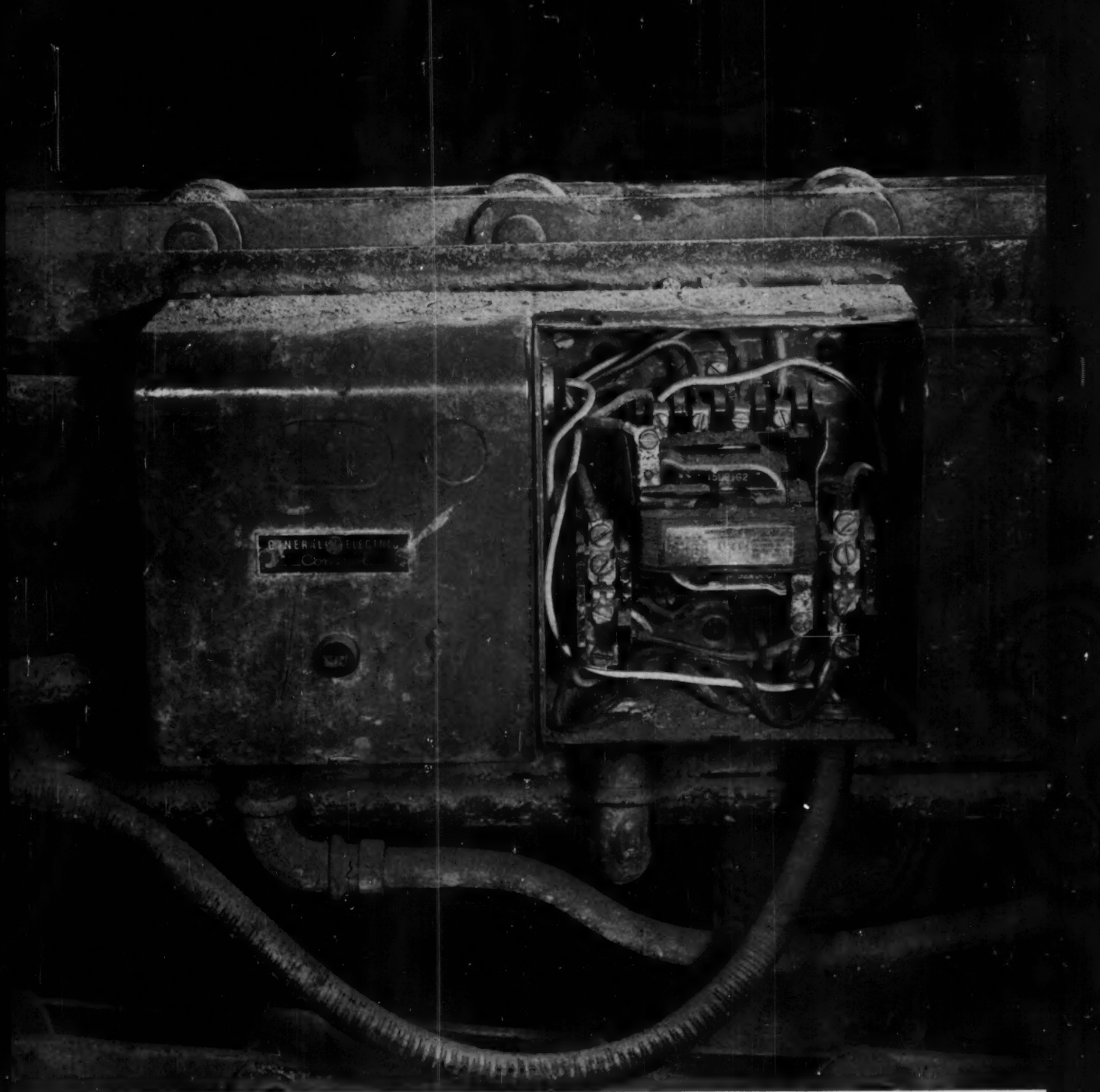
Equipment designers and product engineers can match their most rigid specifications from this *complete* line of Ingersoll-Rand air-cooled air compressors. Top efficiency and operational economy plus important savings in space and weight make I-R compressors the top choice for dependable components.

Ingersoll-Rand air-cooled air compressors are available as bare units, baseplate mounted or tank mounted in sizes ½ through 20 hp. In addition, I-R can furnish high pressure compressors, non-lubricated compressors and vacuum pumps.

Ingersoll-Rand

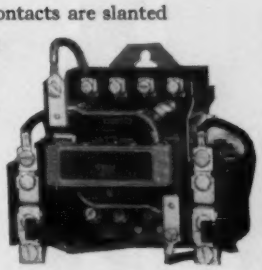
11 Broadway, New York 4, N.Y.

Circle 226 on Page 19



Abrasive Dust Didn't Lick This Starter . . . and on Your Equipment, It Will Meet Customers' Toughest Requirements

After two years in this tough application—covered with abrasive dust—these General Electric magnetic starters are still operating the block conveyor pictured above in a concrete block making plant. Wherever *your* machines or equipment are installed, General Electric starters can give this same outstanding performance that helps improve your product reliability. Result: fewer customer complaints caused by starter breakdown. Some of the reasons? Contacts are slanted so dust slides off. Horizontal wedge-action design reduces contact wear and bounce—helps prevent contact deterioration. Molded coil resists dust, oil, water, mechanical abuse. Plus many other MEASURABLE ADVANTAGES for you and your customers. Call your G-E sales engineer today, or write for GEA-7020. General Electric Co., Section 811-18, Schenectady 5, N. Y.



Progress Is Our Most Important Product

GENERAL ELECTRIC

Circle 227 on Page 19

Veeder-Root announces Veederline:
108 versatile counters
for military, commercial and
industrial applications.
Veederline sets a new standard
in direct-drive high-speed counters.
Typical fields of use range from
navigation, tracking,
radar, ground approach,
fire control and guidance systems
to data processing, gaging,
measuring, machine tool indication
and process totalizing devices.
Veederline — a new range of
single, tandem and
dual counters.
Series 1742:
68 single counters
for basic digital communication.
Series 1758:
28 tandem counters
for additive counting
from a fixed reference
in either direction.
Series 1759:
12 dual counters
for alternate space considerations.
Low torque, low inertia, all rotations.
For new catalog write:
Veederline,
Veeder-Root Incorporated,
Hartford 2, Connecticut
count on...VEEDER-ROOT

Circle 228 on Page 19

VEEDER-ROOT INC.
HARTFORD, CONN.

BERGEN FOUND THE ANSWER

with a custom-engineered non-rotating cable

The Climax of drama and suspense, in our first man-in-space shot, came as the rescue vehicle, a Sikorsky S-58 helicopter, equipped with a completely non-rotating Bergen cable, lifted astronaut Shepard from the sea.

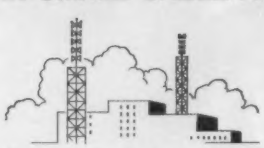
Bergen engineers, working in conjunction with the Breeze Corporation developed a single 3/16 inch, 19 x 7 stainless cable that would carry a weight load equal to the full breaking strength of the cable without rotating. All previous commercial non-rotating cables were found to spin when full weight was applied. Bergen engineers solved this problem by designing a special combination of lays and counter wraps to prevent rotation.

The same engineering staff that found the cable solution applicable to Project Mercury is at *your* service at Bergen. Miniature assemblies with hair-fine wirerope, on up to one-inch O.D. cables and their assemblies, in a wide variety of metals, are carried in stock or quickly custom made. Send specifications or write for catalog.

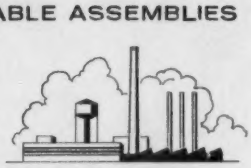
BERGEN
WIRE ROPE CO.
GREGG STREET • LODI, N.J.

BERGEN . . . THE LEADER IN SMALL CABLE AND CABLE ASSEMBLIES

For Military



For Transportation-Communication



For General Industry

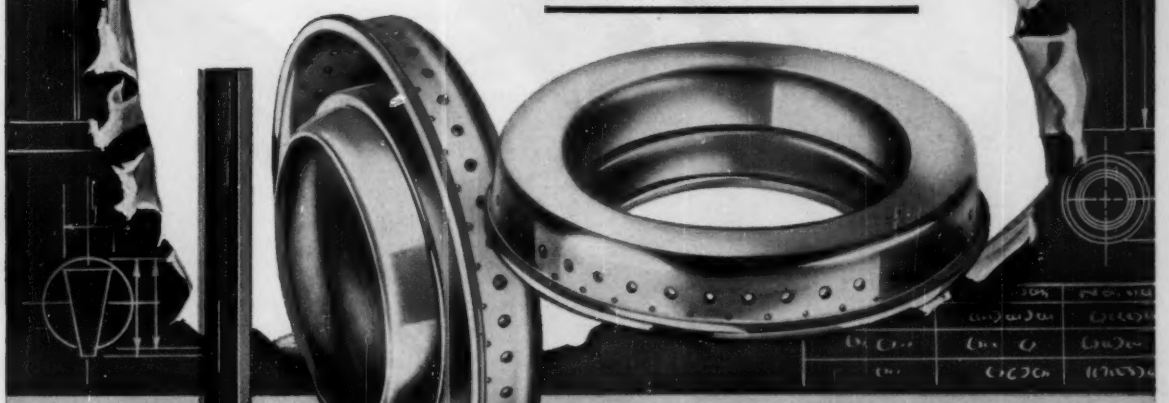
Circle 229 on Page 19

when you count on

MIRRO

you can count on

INGENUITY

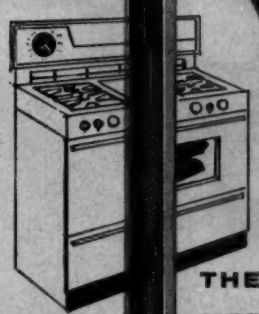


This gas range burner ring, for a manufacturer of '61 Gold Star models, is a case in point. It's a demanding piece to make. Shoulder tolerances must be held within .005" level. Each gas outlet port must direct flame at a *precise* angle. The smaller series of ports asks the theoretically "impossible," by requiring a diameter smaller than the gauge of the metal itself. And it must function consistently in all temperatures, from a dead-cold start to flame-heat.

MIRRO ingenuity devised the dies and draws, noodled out the indexing equipment for series punching of outlet ports, and supplies the completed piece in volume, meeting the tough A.G.A. laboratory standards at a practical price.

There's a whole lot back of a job like this. Years of aluminum know-how. Highly capable engineers and designers. MIRRO's own rolling mill and metallurgical staff. Complete finishing facilities. Rigid quality control. And the constant awareness that pennies saved mean dollars earned, on any high-volume contract.

Count on MIRRO and you can count on *all* of that, backing any contract job you place with us. We'd welcome a chance to estimate or advise.



THE METAL MEN OF MANITOWOC

COUNT ON MIRRO for any production line requiring aluminum components...appliances, housewares, automotive, or Government contracts.

MIRRO
THE FINEST ALUMINUM

MIRRO ALUMINUM COMPANY, MANITOWOC, WISCONSIN

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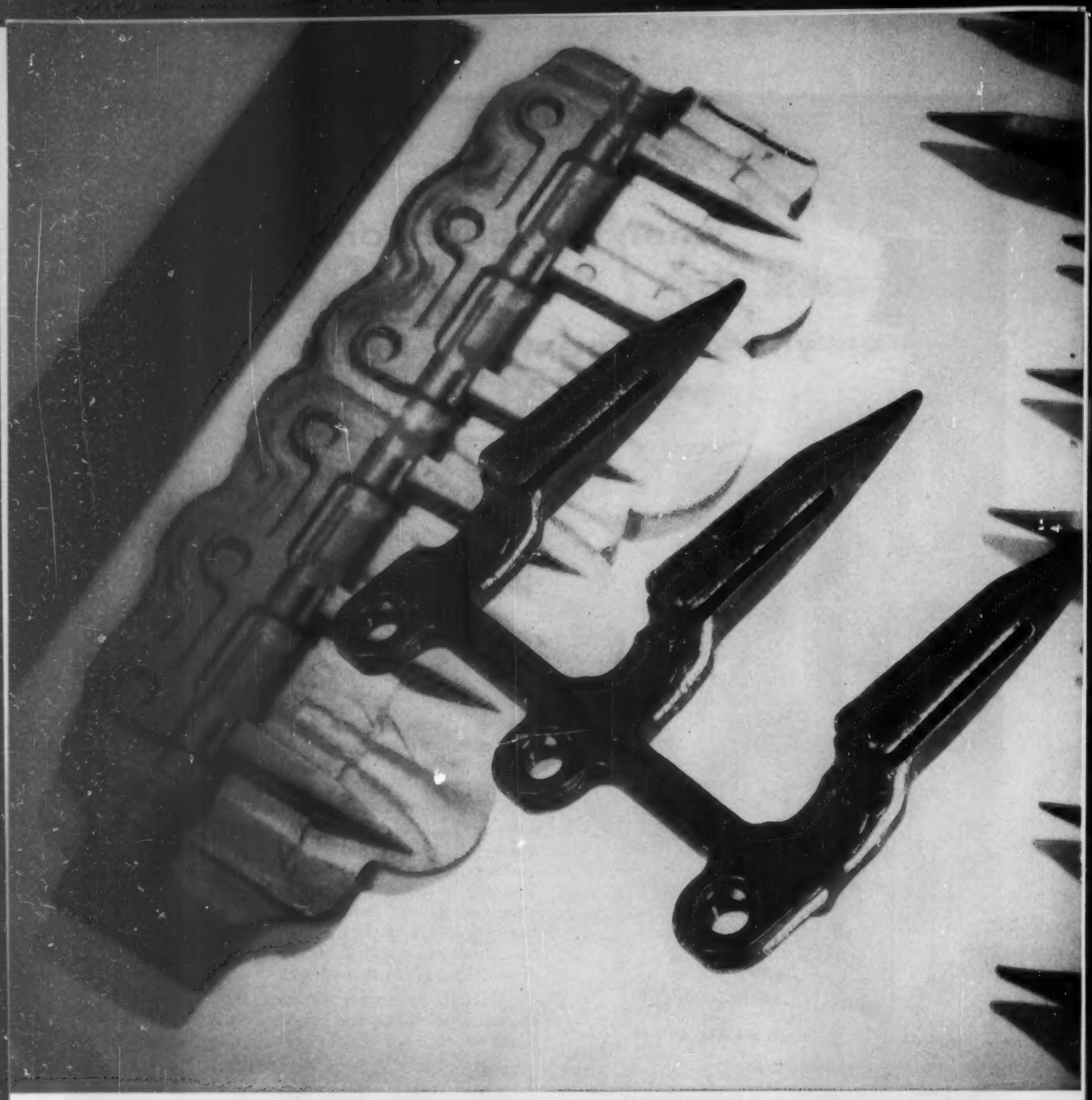


United States Steel offers the widest range of carbon and alloy bar sizes, shapes and grades available in the industry.
We're a single source for all your requirements.

Sickle guard forged from USS Bar Stock for longer life

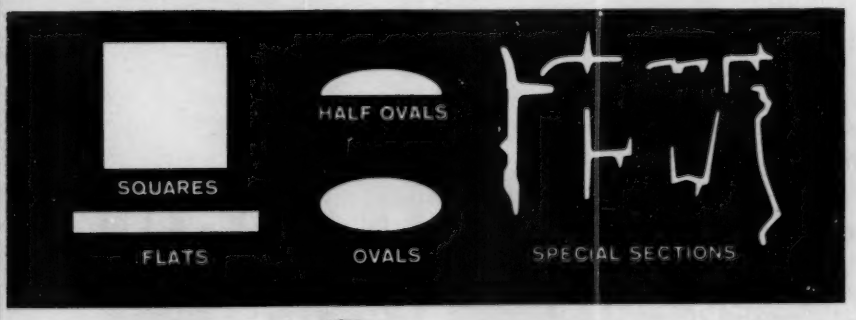
This forged and machined part will last longer than the cast design it replaced even though it weighs 12% less and costs less. It's a sickle guard used on the cutting platform of a line of John Deere self-propelled combines, and is manufactured by Buchanan Steel Products Corporation, Buchanan, Michigan.

John Deere wanted the part to be thinner for maximum cutting coverage at high speeds, and shock- and wear-resistant so that it could self-sharpen the blade. The designers specified forged steel because it would mean a lighter, tougher, more durable part. The part is forged from bar flat steel produced by United States Steel.

Design and fabrication possibilities are virtually unlimited with USS Carbon and Alloy Bar products. Forgings are usually fabricated from USS flats, rounds or round-cornered squares. And nowhere else can you get the range of sizes, shapes and grades offered by USS. You name it —we have it. Just call our nearest sales office, or write United States Steel, Room 6328, 525 William Penn Place, Pittsburgh 30, Pennsylvania.

United States Steel Corporation • Columbia-Geneva Steel Division • Tennessee Coal and Iron Division • United States Steel Supply Division • United States Steel Export Company

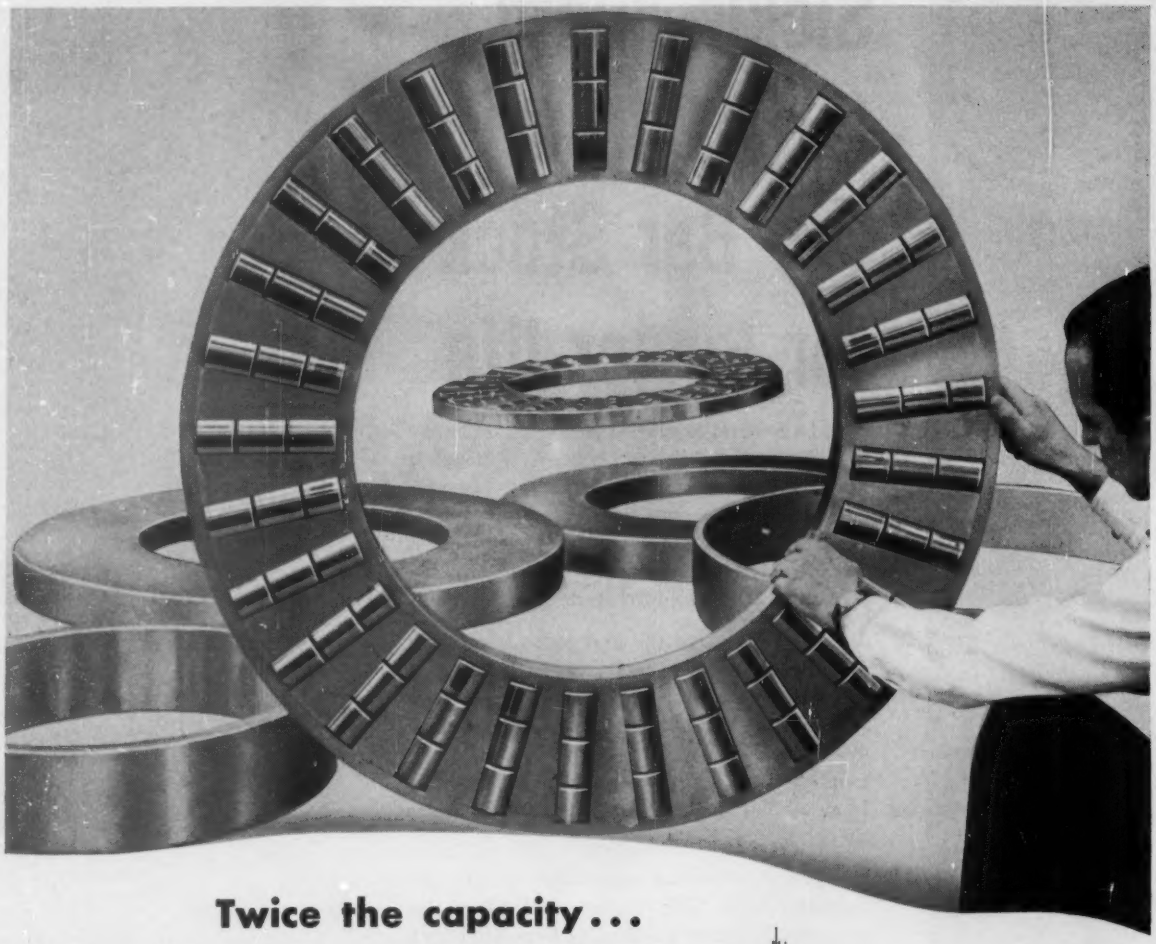
This mark tells you a product is made of modern, dependable Steel



USS United States Steel

TRADEMARK

Please direct inquiries to advertiser, mentioning MACHINE DESIGN



Twice the capacity... without increasing radial space!

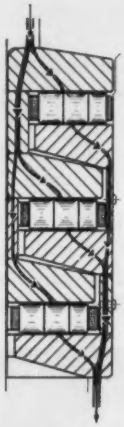
ROLLWAY®

TANDEM THRUST BEARINGS

Rollway Tandem Thrust Bearings like the one shown here are continuing to prove themselves in long, trouble-free performance. This 5,000-pounder is built into a giant plastics extruder at one of the world's largest chemical plants, and provides a dynamic capacity of over 4.8 *million pounds!*

Precision built, it has 165 crowned cylindrical rollers mounted in two tandem stages. Distributing the load axially, it permits reduction in the radial space requirement to house a bearing of comparable thrust capacity.

Whatever your application, Rollway has a thrust bearing that will do the job better. Ask for catalog PT-659.



Arrows indicate path of thrust load in tandem-type bearing.

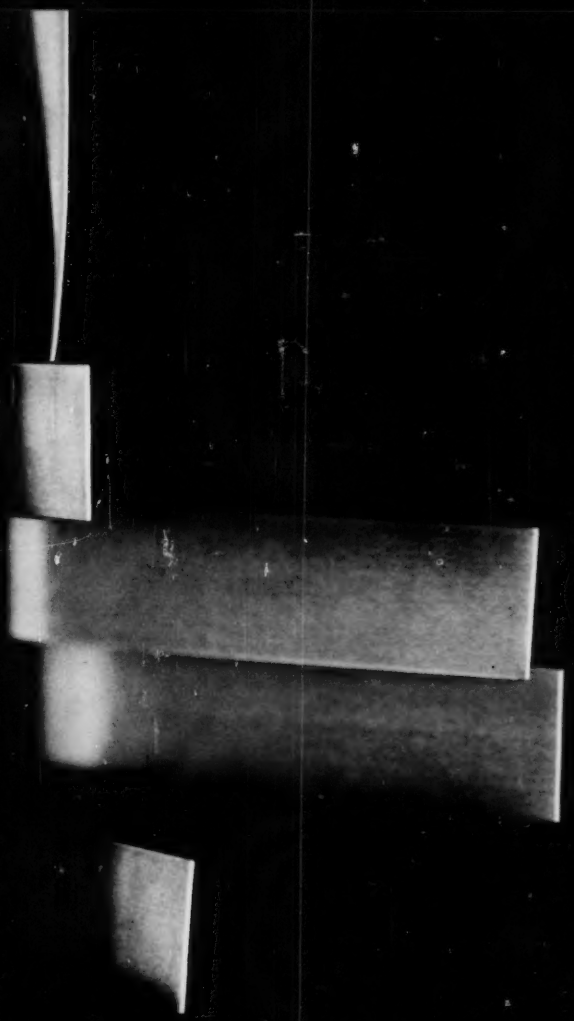
Drawing at left illustrates *three-stage* design —one of the larger sizes in the Rollway-originated tandem thrust series. It is included in the broad range of Rollway thrust bearings that offers seven *standard* cataloged types . . . plus special - purpose types made to your order.

ROLLWAY®
BEARINGS
COMPLETE LINE OF RADIAL AND THRUST CYLINDRICAL ROLLER BEARINGS

ENGINEERING OFFICES: Syracuse • Boston • Chicago • Detroit • Toronto • Pittsburgh • Cleveland • Seattle • Houston • Philadelphia • LosAngeles • SanFrancisco

Circle 231 on Page 19

Circle 232 on Page 19→



FINGERS OF STEEL . . .

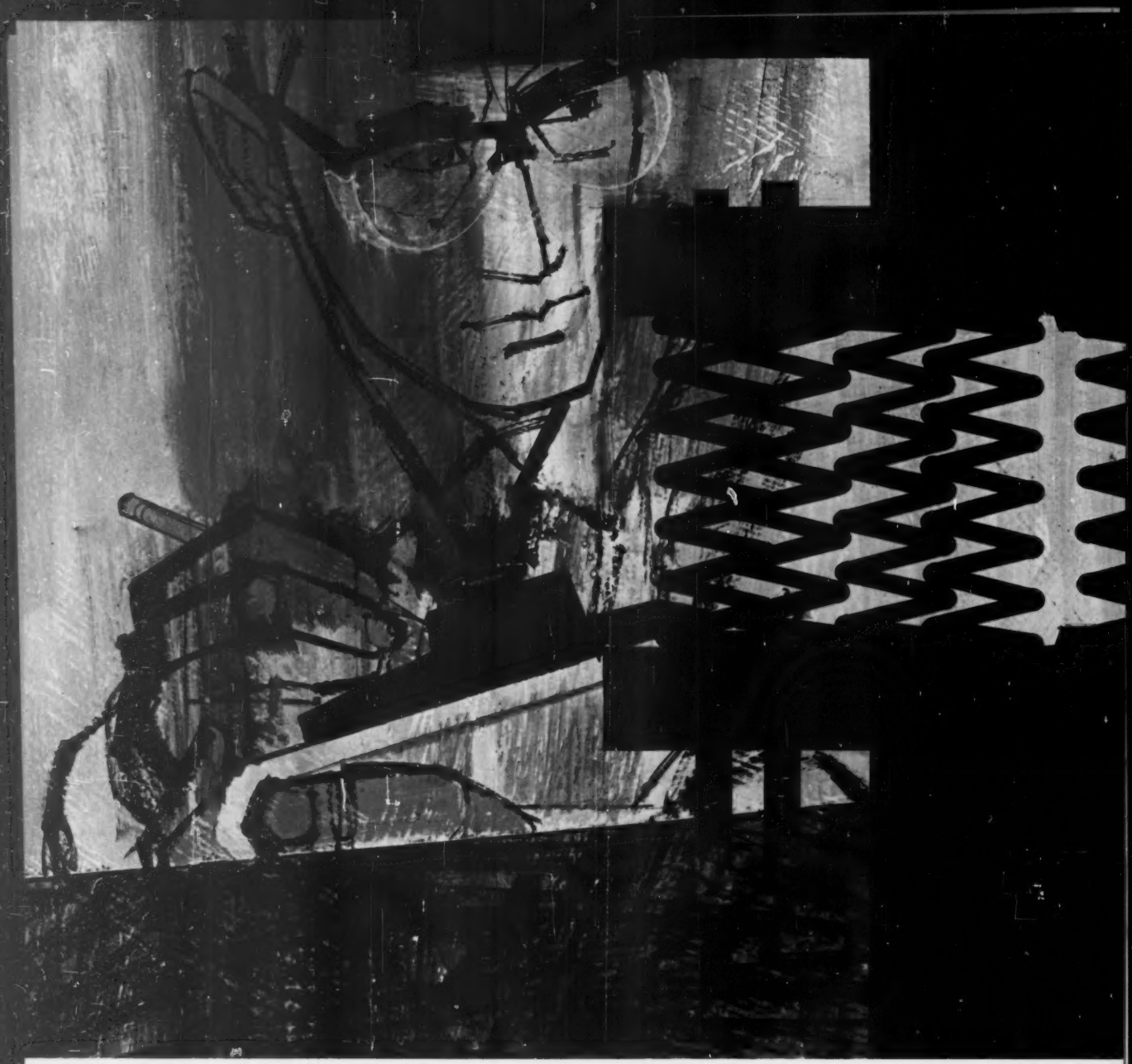
high-carbon spring steel from the Athenia Steel Division of National-Standard is available in widths up to 6½" tempered and 16" cold rolled or annealed, with thicknesses from .001" to .065".

The high quality and uniformity of Athenia spring steel is the result of precision rolling, polishing and slitting to rigid standards on the most modern equipment. Athenia Steel is available from National-Standard Company, Clifton, New Jersey, and from the following: **National-Standard Warehouse, Plainville, Conn.; D & B Steel Co., Cleveland; Krusen Wire & Steel Co., Los Angeles; Lapham-Hickey Steel Corp., Chicago; Voss-Davidson Steel Co., Detroit; Zurbach Steel Co., Somerville, Mass., Plainville, Conn.**

For technical information, write to . . .

NS
NATIONAL STANDARD COMPANY

Athenia Steel Division
NATIONAL-STANDARD COMPANY
Clifton, New Jersey



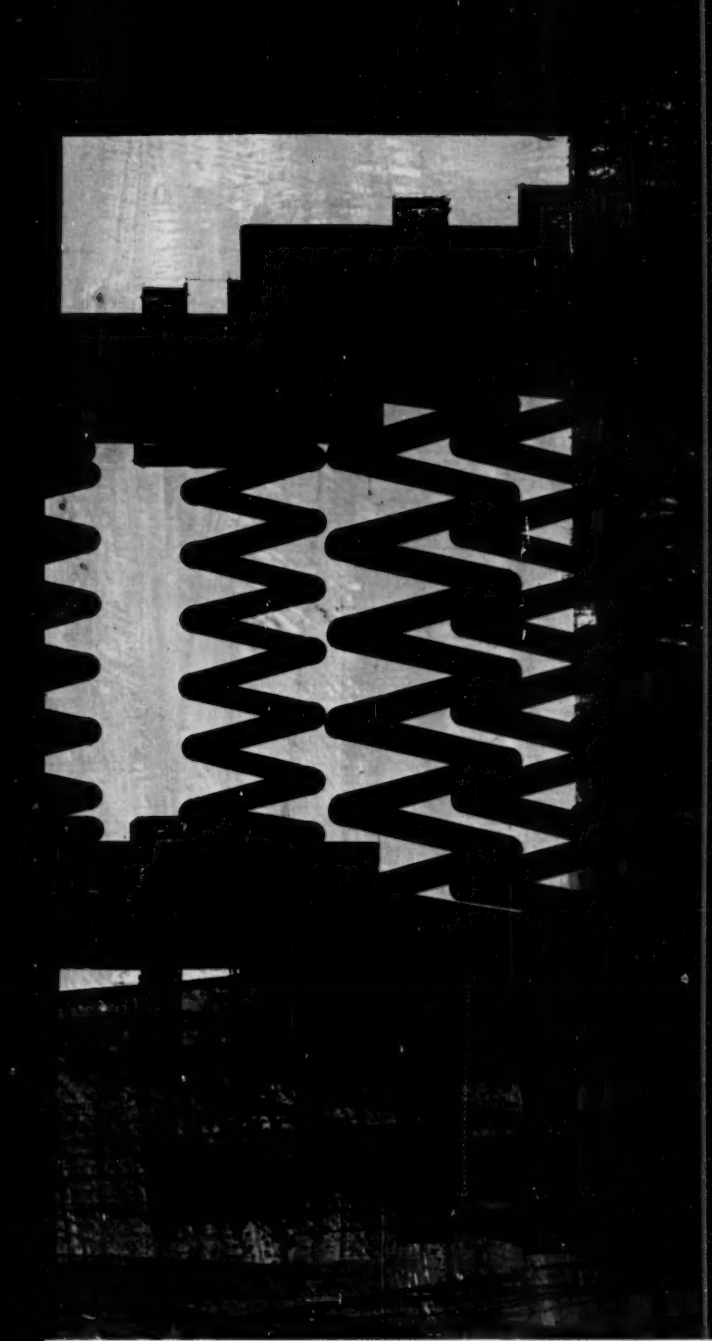
New N-S stainless wire tests 100,000 psi

From National-Standard research and development comes NS-355—a stainless steel, corrosion resistant spring wire having much greater elasticity than conventional stainless steel wire.

NS-355 is a semi-austenitic alloy, originally developed for use in heavy wire sections fabricated from bar, billet or plate stock—applications requiring corrosion resistance, strength, durability and hardness. National-Standard searched for a way to apply these outstanding advantages to highly stressed spring wire applications.

After comprehensive research in processing methods, National-Standard metallurgists developed the capability to draw NS-355 alloy into exceptionally high-tensile spring wire. Spring production tests were made on .125 and .075 inch diameter wire samples with a tensile strength over 100,000 psi higher than music spring wire, proving that NS-355 wire could be satisfactorily run on automatic coiling machines with excellent formability.

Further evaluation tests were conducted in the Spring Laboratory of Bendix Corporation, South Bend, Indiana. Here, engineers ran life cycle tests on NS-355 stainless steel springs and determined spring modulus values. On a mechanical cycling unit—eight springs to a fixture—NS-355 springs

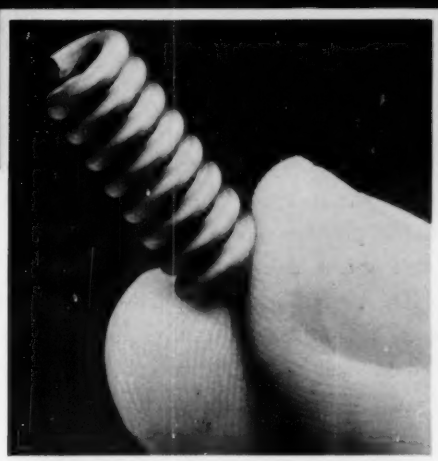


above music wire

were subjected to 600 compression cycles per minute—a total of 10-million cycles under stresses from 20,000 to 150,000 pounds.

The development of NS-355 stainless steel spring wire creates an entirely new solution to highly stressed, corrosion resistant spring requirements for jet engines, food and beverage equipment, chemical machinery and a growing number of other special wire applications.

For more information about new NS-355 stainless steel spring wire, or help in developing high quality wire to meet your special or unique applications, write National-Standard Company, Niles, Mich.



National-Standard NS-355 stainless steel springs with an index as low as 3 can be formed on automatic coiling machines without breakage.

NS NATIONAL STANDARD COMPANY

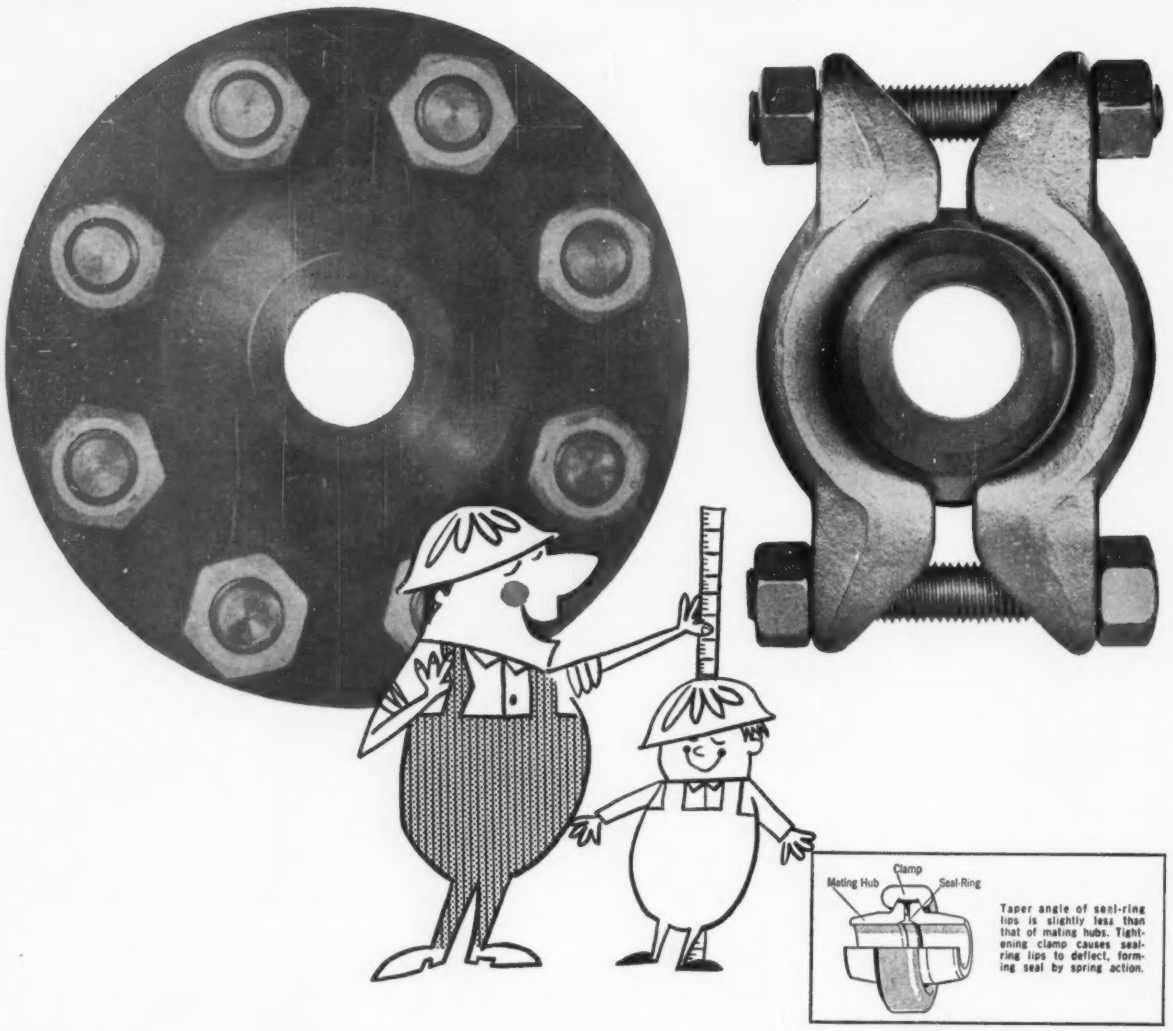
Manufacturer of Specialty Wire & Metal Products

NATIONAL-STANDARD COMPANY

Niles, Michigan

61-W03

Grayloc Pipe Connections Save 1/3 the Space



Mating Hub
Clamp
Seal-Ring
Taper angle of seal-ring lips is slightly less than that of mating hubs. Tightening clamp causes seal-ring lips to deflect, forming seal by spring action.

GRAYLOC® pipe connections are up to one-third smaller than flanged connections with comparable maximum pressure ratings. They save wasted space — cut unit weight and assembly time drastically.

An all steel assembly, GRAYLOC employs a pressure aided seal that can be assembled or disconnected in minutes. The heart of the assembly — the seal ring — is completely reusable.

Although GRAYLOC connections are manufactured in standard stock sizes from 1″ to 30″, special sizes for special applications are available on request. Corrosion resistant metals can be provided on short notice.

You can use GRAYLOC connections in your piping system. They'll save you maintenance and assembly time, space and money. To learn how, write for the new GRAYLOC catalog.

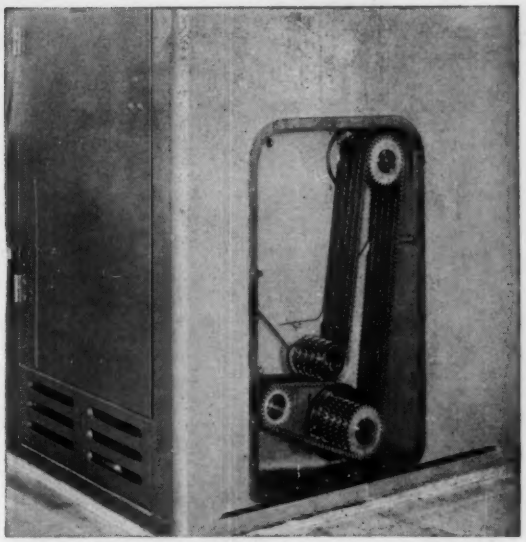
GRAYLOC SALES DIVISION

GRAY Tool Company

6112

P. O. BOX 2291 • HOUSTON 1, TEXAS • RIverside 7-1240

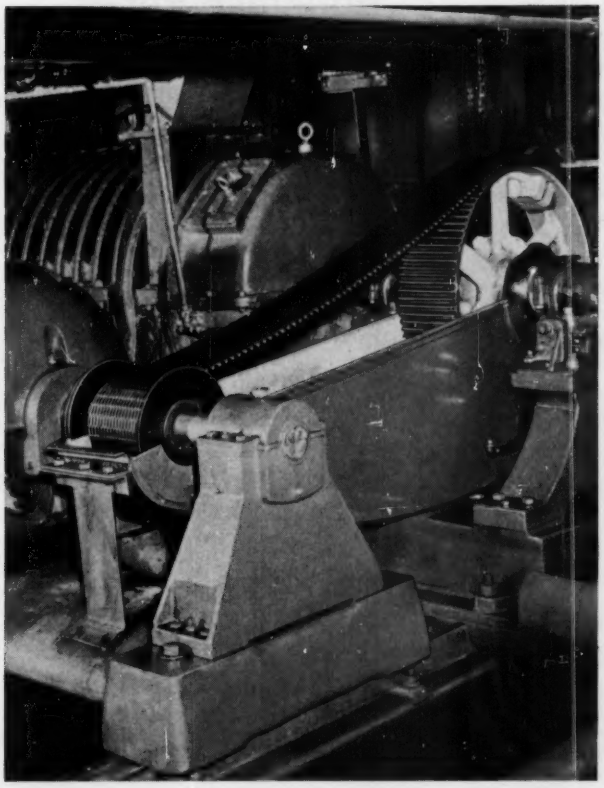
Circle 233 on Page 19



FOR DRIVING A SERIES OF SHAFTS on fixed centers, Link-Belt silent chain assures positive transmission of power. On applications requiring reverse rotation of shafts, Link-Belt duplex silent chain is capable of driving wheels from either side of chain.

Link-Belt silent chain

for drives that can't afford to slip



Smooth, positive engagement assures full power transmission

Continuous, nonslip operation for many years with only routine attention—this is a common experience with Link-Belt silent chain. Where other types of drives are impractical due to slipping tendencies, this modern chain drive delivers positive transmission of full-rated horsepower.

Link-Belt silent chain assures efficiency for either large or fractional-horsepower drives. Easy assembly in tight spaces permits built-in drives, compact housings. Close grouping of equipment saves valuable floor space. High humidity, temperature have no effect on performance. Ratios as high as 10-to-1 are accommodated on relatively short centers.

Available in a full range of sizes. For complete information, call your nearby Link-Belt office. Ask for Book 2425.

WHERE SPACE IS LIMITED, compact Link-Belt silent chain drives permit close grouping of equipment. High ratio reductions are easily accommodated on relatively short centers.

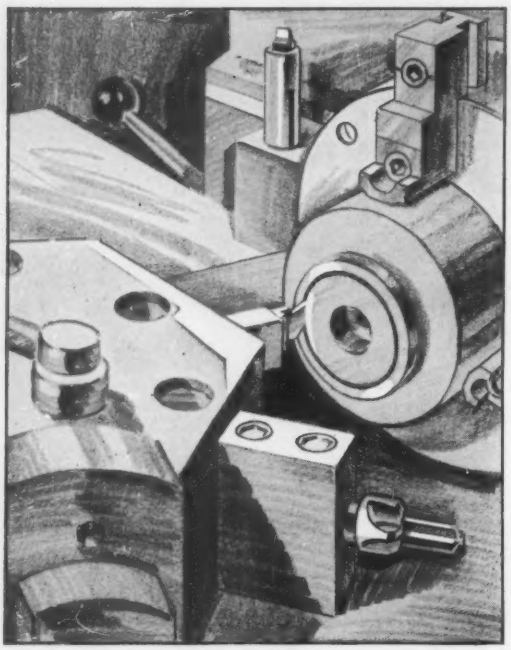
LINK-BELT

15,809

SILVERSTREAK SILENT CHAIN DRIVES

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Warehouses, District Sales Offices and Stock Carrying Distributors in All Principal Cities. Export Office, New York 7; Australia, Marrickville (Sydney); Brazil, Sao Paulo; Canada, Scarboro (Toronto 13); South Africa, Springs; Switzerland, Geneva. Representatives Throughout the World.

THE FREE MACHINABILITY of EATON PERMANENT MOLD GRAY IRON CASTINGS



Permits Higher Feeds and Speeds, Gives Longer Tool Life

Eaton Permanent Mold Gray Iron Castings are free from inclusions and hard spots, permitting higher machining feeds and speeds, and substantially increasing tool life.

The fine dispersion of graphite and dense, non-porous, homogeneous structure make this an ideal material for many difficult machining operations where high surface finish, accurate dimensional results, and sharp corners are essential. Machining of threads is clean-cut, with good surfaces and no tearing.

Eaton Permanent Mold Iron is recommended for such critical applications as bearing retainers, connecting rods, pulleys, gear blanks, valve bodies, valve plates, hydraulic components, refrigeration and air conditioning parts. Eaton Castings are produced in sizes from 1/10 of a pound to 50 pounds.

When desirable, Eaton Permanent Mold Castings can be hardened to 40-50 Rockwell "C".

CONSIDER THESE EATON ADVANTAGES

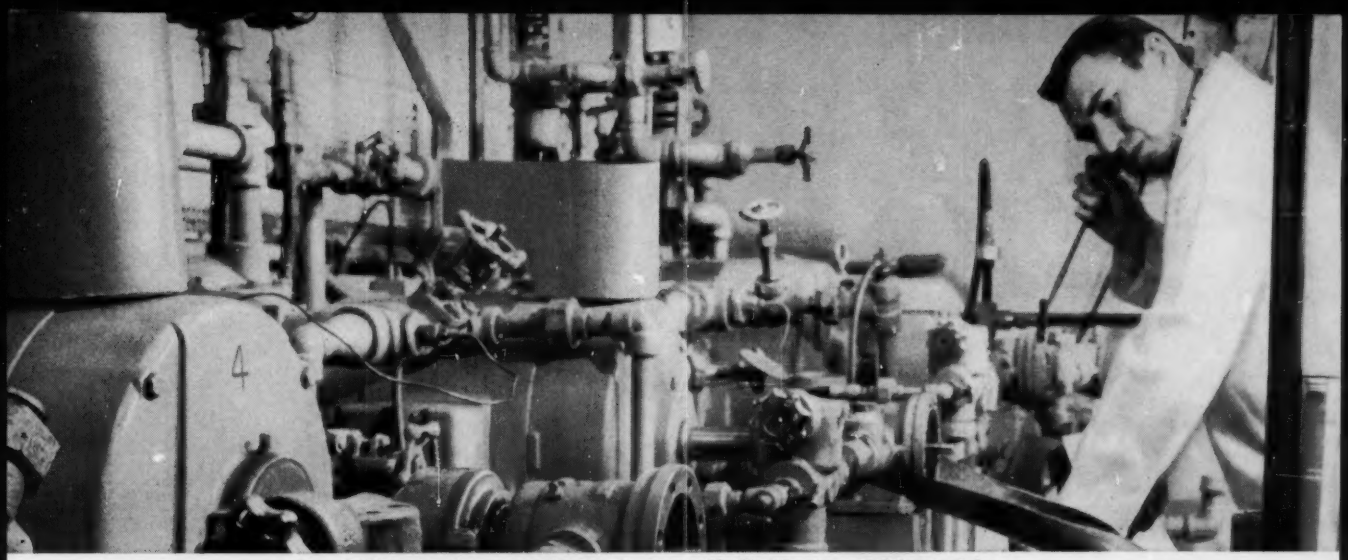
- ★ Dense, non-porous, homogeneous structure
- ★ Freedom from inclusions
- ★ Excellent tensile strength
- ★ Ability to take a high surface finish
- ★ Freedom from leakage under pressure
- ★ Uniformity of castings
- ★ Properly annealed; no growth or distortion
- ★ Hardenable to 40-50 Rockwell "C"

Send for Illustrated Descriptive Literature.

EATON

FOUNDRY DIVISION
MANUFACTURING COMPANY
VASSAR, MICHIGAN

PRODUCTS: Engine Valves • Tappets • Hydraulic Valve Lifters • Valve Seat Inserts • Marine Engines • Marine Drives Pumps • Truck and Trailer Axles • Transmissions • Permanent Mold Iron Castings • Automotive Heaters and Air Conditioners Fastening Devices • Cold Drawn Steel • Stampings • Forgings • Leaf and Coil Springs • Dynamatic Drives and Brakes Powdered Metal Parts • Gears • Variable Speed Drives • Speed Reducers • Differentials • Centralized Lubrication Systems



Listening for pump chatter. Here—in Shell's Martinez, California, laboratory Shell Tellus hydraulic oils are subjected to the most demanding tests.

BULLETIN:

Shell presents a question-answer guide to help you select the hydraulic oils for top performance

Selecting the proper hydraulic fluid for your equipment can be one of your most important decisions. And it can pay off in many ways. Less down-time. Longer equipment life. Lower cost per unit.

Here are six bench marks to help you pick the best hydraulic oil for your plant requirements.

1. Does it have good oxidation stability? Oxidized hydraulic oil can form gums, lacquers and other deposits which may foul moving parts. Shell Tellus Oils are carefully refined to remove unstable, sludge-forming components—then fortified with a Shell-developed oxidation inhibitor.

2. Will it resist foaming and emulsification? Pump chatter and erratic operation are often the result of pump cavitation, brought on by oil foaming. Tellus® Oils contain additives to help prevent foaming.

3. Does it fight rust and corrosion? It is difficult to exclude all moisture from a hydraulic system. And moisture can form troublesome rust. Shell Tellus Oils have been carefully compounded to resist corrosion.

4. What are its lubrication qualities in continuous service? Shell Tellus Oils form a clinging, oily film on mating metal surfaces. This maintains a constant guard against wear.

5. How does it react to temperature changes? This is a key factor in the performance of hydraulic equipment. Careful selection of the proper viscosity grade of Tellus assures satisfactory operation of your system over its entire temperature range.

6. Is it available in several viscosity grades? Shell Tellus Oils are available in a broad range of viscosity grades. There's a special grade for virtually every hydraulic requirement.

Ask your Shell Industrial Products Representative for facts on Tellus Oils. Or write: Shell Oil Company, 50 West 50th St., New York 20, N. Y.

A message to manufacturers of hydraulic equipment

There is a Shell Tellus Oil suited for your equipment.

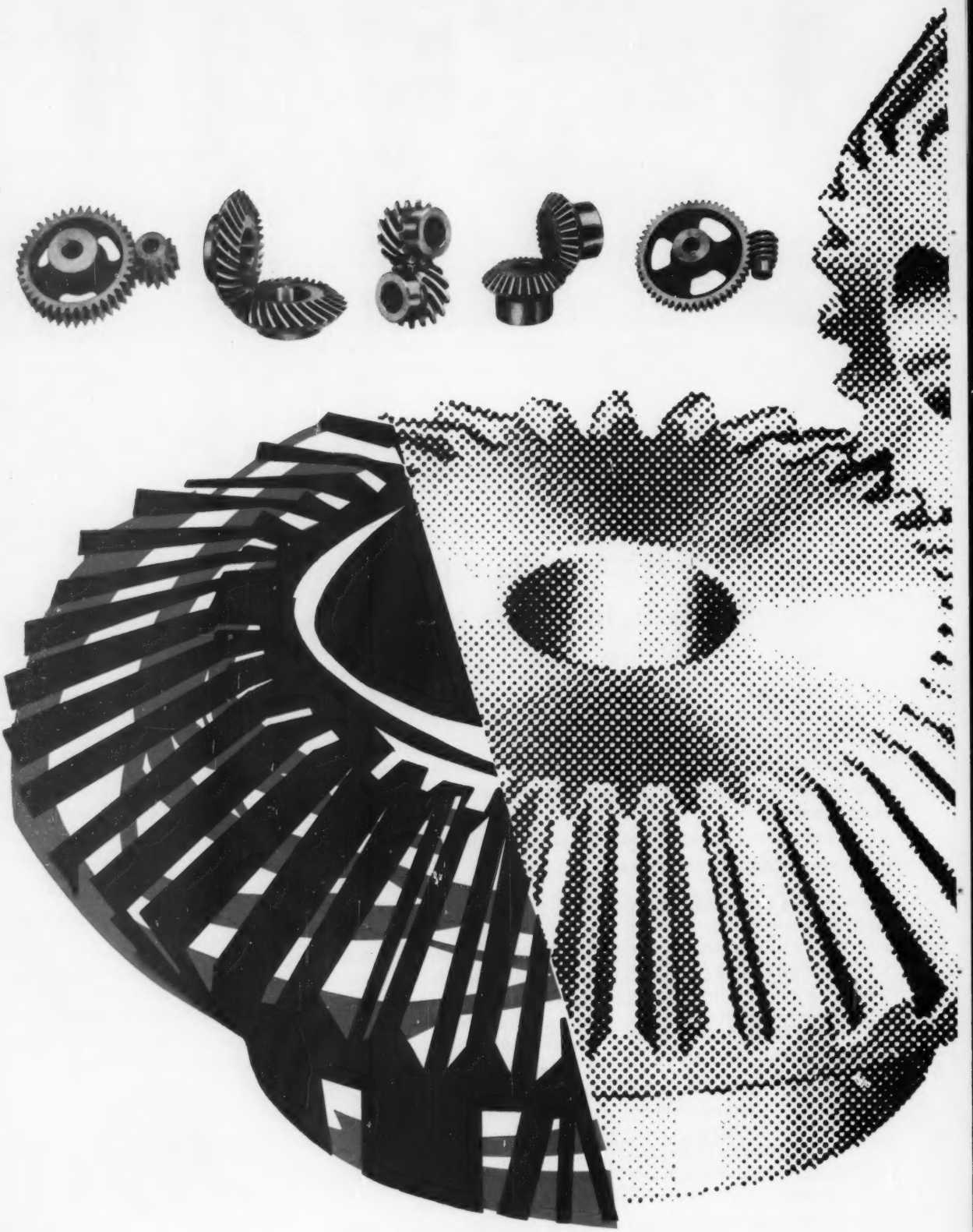
1. Your customers can get Tellus Oils at Shell depots everywhere. Readily available throughout the world.

2. Quality is consistently high. Tellus always delivers top performance.

SHELL

A BULLETIN FROM SHELL
—where 1,997 scientists are working to provide better products for industry

Circle 236 on Page 19



Morse goes into gear!

with a new line of 20° pressure-angle stock gears at the price of 14½° p.a. gears. Morse introduces a new concept of value by offering 20° p.a. sets designed to replace 14½° p.a. gears. You pay no more and get over 30% more horsepower capacity. Spur, bevel, miter sets, helical, worm-and-gear sets are made from only the finest materials. Gears are produced with minimum plain bores to extremely close tolerances. Finish is excellent. If you're a wise gear-buyer you'll call your Morse distributor now! He's in the Yellow Pages. Morse Chain Company, Dept. 6-91, Ithaca, N.Y.

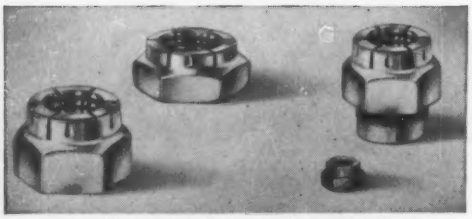
MORSE

A BORG-WARNER INDUSTRY

BW

Self-locking nut that locks without seating,

FLEXLOC



Left to right: full height, thin, microsize, clinch nut.

Three of the most significant features of 1-piece all-metal FLEXLOCs: they are self-locking; they lock without seating; they won't work loose, regardless of vibration.

With FLEXLOC no lockwashers, jam nuts, cotter pins or other auxiliary locking devices are needed. There's nothing extra to put together, come apart or get lost. Your design problem is simplified. Assembly time and costs are reduced. And maintenance expenses are lowered because FLEXLOCs can be readily removed and repeatedly re-used.

What's more, since FLEXLOCs lock without seating, they serve as stop nuts, staying put anywhere on bolt or stud once 1½ threads of bolt are past top of FLEXLOC. And there's no need to worry about the effect of "shake, rattle or rock" on FLEXLOCs. They just won't budge, even in the face of terrific impact, ceaseless vibration.

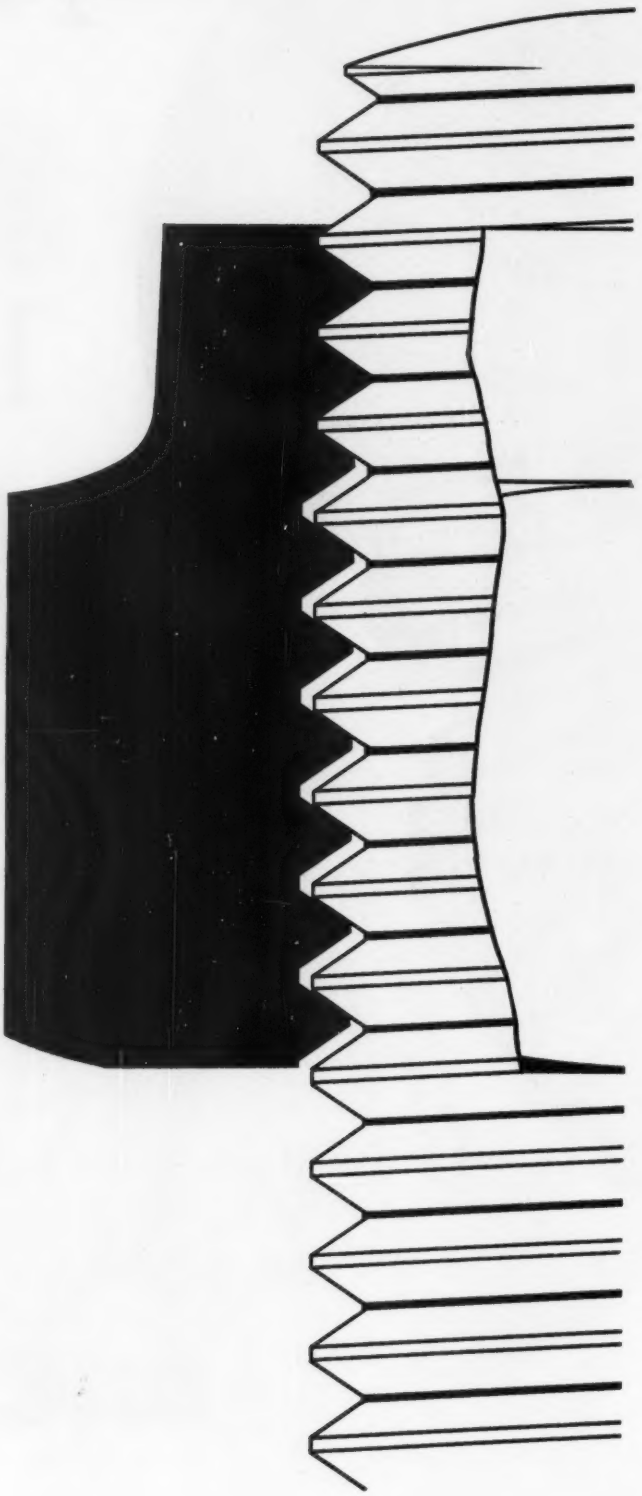
FLEXLOC Clinch Nuts—Designed for use in thin-section materials, they make blind fastening easy, are ideal where dismantling and reassembly is required. They are simply clinched into the material to be assembled and become an integral part of it. Use FLEXLOC Clinch Nuts in place of anchor, weld or cage nuts.

See your authorized industrial distributor for complete information on sizes, materials and finishes. Or write Standard Pressed Steel Co. — manufacturer of precision threaded fasteners and allied products in many metals, including titanium. INDUSTRIAL FASTENER Division, SPS, JENKINTOWN 18, PENNSYLVANIA.

FLEXLOC Nuts

PRODUCT	SIZES
Full Height	#2 through 2"
Thin Type	#6 through 1½"
Microsize	#0 through #4
Clinch—regular	#4 through 5/16"
Clinch—microsize	#0 through #4

Regular clinch nuts come in 7 shank lengths, microsize clinch nuts in 2

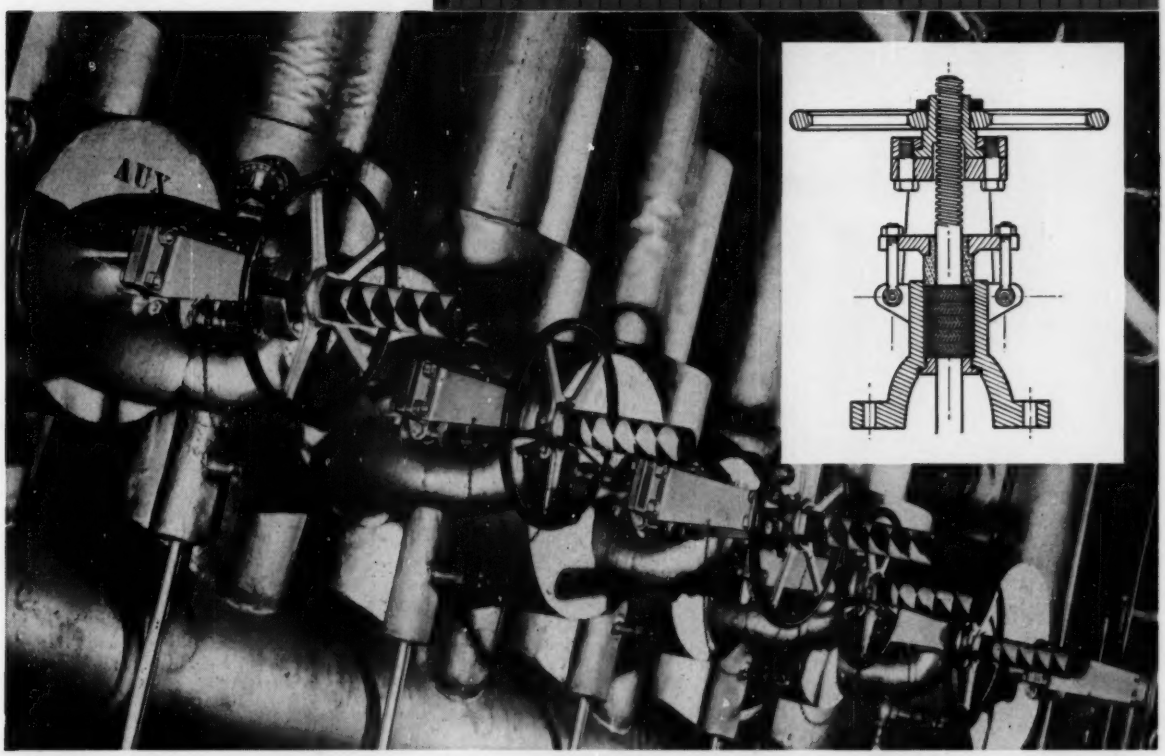


SPS

where reliability replaces probability

DU PONT

TEFLON®



Packings of asbestos and TEFLON® TFE in 7 steam valves stopped leakage...reduced maintenance...saved $280 per year

CAN YOU AFFORD NOT TO USE TEFLON?

Packings made with TEFLON are your logical and most economical choice whenever severe environmental conditions are encountered, AND in all cases when you want—

... greatly reduced packing maintenance

... reduction of replacement costs

... reduced cylinder and shaft wear

... greater standardization with reduced packing inventories

... the competitive advantage of quality and dependability

If any of these considerations are important to your design, the choice of any other kind of packing material might well be wasteful.

DU PONT
REG. U. S. PAT. OFF.

The packings: asbestos impregnated with a Du Pont TEFLON TFE-fluorocarbon resin. The application: main distribution control valves on the boiler header shown above, handling steam at 150 psi. and 356°F. The performance advantages: the packings do not leak . . . do not need retightening . . . last indefinitely . . . valves turn easily without "persuaders". Unlike oil, grease and graphite additives, which squeeze out and leave a dry, abrasive base, the impregnations of TEFLON make a lasting mechanical bond with the asbestos. The cost savings: average savings per valve of $10 per year on repacking and retightening formerly necessary, and $30 per year formerly lost through leaking steam —a total of $280 per year for the 7 valves.

Under more severe service conditions, TEFLON resins are often the only answer. These materials are inert to virtually all chemicals and solvents, at temperatures from −450°F. to 500°F.

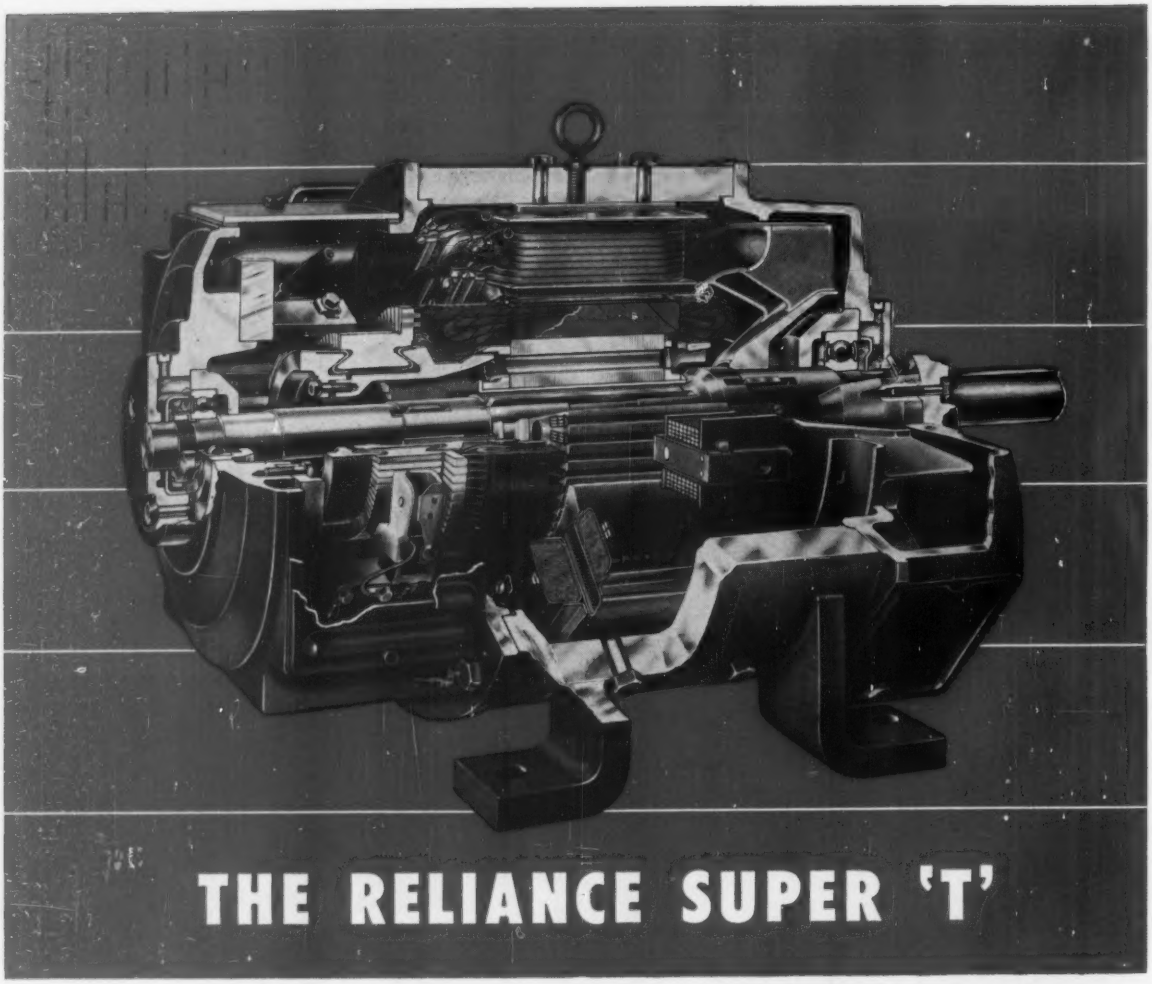
Consult your supplier about the many constructions available in packings made with TEFLON. Write for the new booklets: "Packings for Valves and Pumps", and "Designing with TEFLON". Address: E. I. du Pont de Nemours & Co. (Inc.), Dept. MD928, Room 2507T, Nemours Building, Wilmington 98, Delaware. **In Canada:** Du Pont of Canada Limited, P. O. Box 660, Montreal, Quebec.

TEFLON®
FLUOROCARBON RESINS

TEFLON is Du Pont's registered trademark for its family of fluorocarbon resins, including TFE (tetrafluoroethylene) resins and FEP (fluorinated ethylene propylene) resins.

BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY*

Circle 239 on Page 19



THE RELIANCE SUPER 'T'

A New Kind of D-c. Motor With DYNAMIC RESPONSE

Here is a motor built to make maximum use of d-c. flexibility. The Super 'T' puts Dynamic Response into starts, stops, and speed changes. Dynamic Response gives you a 50% increase in torque and a 50% decrease in reaction time.

This top performance is due to advanced balanced design. Lighter, small diameter armatures cut mechanical inertia 50%. Superior Class B insulation, gives extended life even at temperatures as great as 130°C.

Top grade insulation plus engineered ventilation lets the Super 'T' take tremendous overloads. In fact, the Super 'T' can develop double normal horsepower during starts, stops, and speed changes.

The Super 'T' is a compact power package, designed inside and out for tough industrial service. From appearance to performance, the Reliance Super 'T' with Dynamic Response is today's most modern industrial motor.

C-15TT

Product of the combined resources of Reliance Electric and Engineering Company and its Master and Reeves Divisions

RELIANCE ELECTRIC AND ENGINEERING CO.

DEPT. 28-9, CLEVELAND 17, OHIO
Canadian Division: Toronto, Ontario
Sales Offices and Distributors in Principal Cities

Duty Master A-c. Motors, Master Gearmotors, Reeves Drives, V★S Drives, Super 'T' D-c. Motors, Generators, Controls and Engineered Drive Systems.

Three great names in couplings

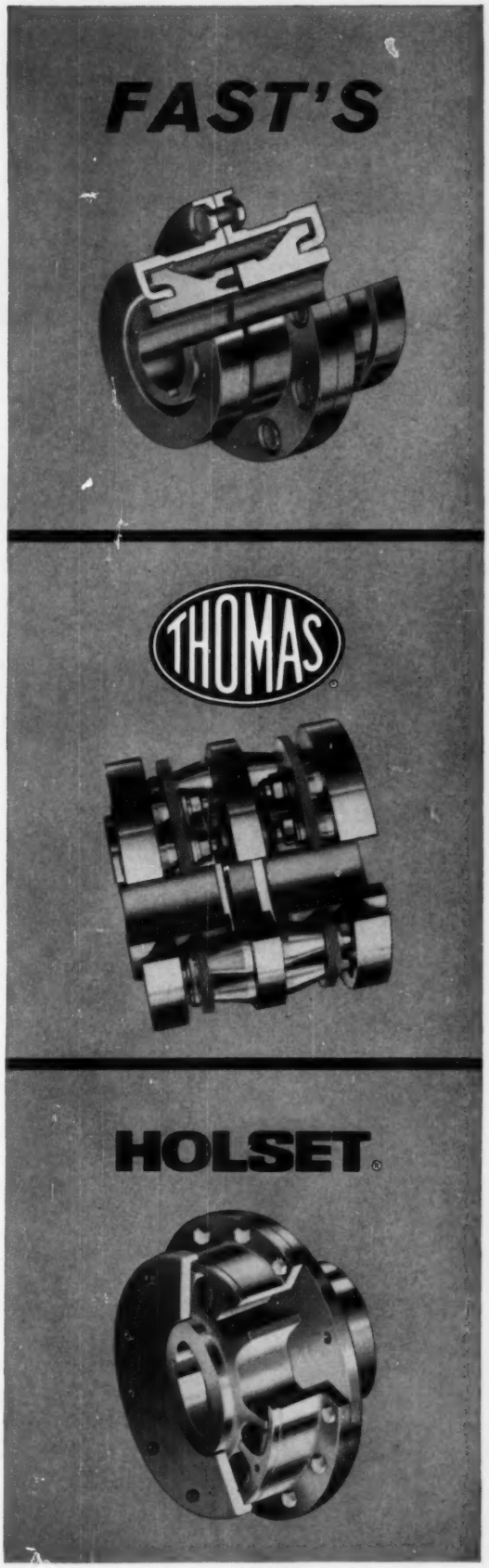
NOW CARRY THIS CORPORATE SYMBOL

KOPPERS®

With the acquisition of the Thomas Flexible Disc Coupling line, Koppers now provides engineering solutions to a wide range of industrial coupling problems. Need a lubricated gear-type coupling for transmitting high loads? Koppers world-famous Fast's coupling line does the job on shafts up to 32 inches. Need a maintenance-free flexible-disc coupling with no backlash? The highly engineered Thomas line holds the answer—with miniature couplings as small as 1/12th of an ounce. Need a coupling to absorb impact or vibration? The Holset line of resilient, non-lubricated couplings protects equipment in most diesel, compressor and shock load applications.

Because each of these coupling lines has its particular application in industry . . . and because each is a recognized name in the power transmission field . . . you can continue to buy them by brand—just as you have in the past. Of considerable importance are the experienced, extensive engineering and manufacturing services of the entire Koppers organization that are available to help you with your power transmission problems . . . in any size, in any quantity, for any use.

KOPPERS COMPANY, INC.
COUPLING DEPARTMENT
Baltimore, Md. • Warren, Pa.
Engineered Products Sold with Service



Circle 241 on Page 19

Now! A new rugged line of versatile foot switches from Cutler-Hammer

Smartly styled... four types... designed to be used many different ways

Now you can get the same high quality in foot switches you find in Cutler-Hammer motor starters.

Our new foot switches are designed to be stepped on, kneed, elbowed, palmed or whatever method you can think of to use them. Heavy gauge metal and rugged construction will keep these switches operating long after others have failed.

You get versatility, too. The heavy duty, side treadle switch has three interchangeable operating arrangements that can be made easily in the field by just changing the position of a nylon cam, and all are styled alike to give you uniformity in appearance.

Be sure to get full details from your Cutler-Hammer distributor and send for Pub. LO-91-T243.

What's new at Cutler-Hammer?
We've geared up for the great growth of technology coming in this decade... with new, better products like the foot switches, new engineering talent, new plant facilities. If you're planning ahead, let's get together. Maybe we could help you with your electrical control and automation plans. Get in touch with the Cutler-Hammer Sales Office nearest you.

WHAT'S NEW? ASK...

CUTLER-HAMMER

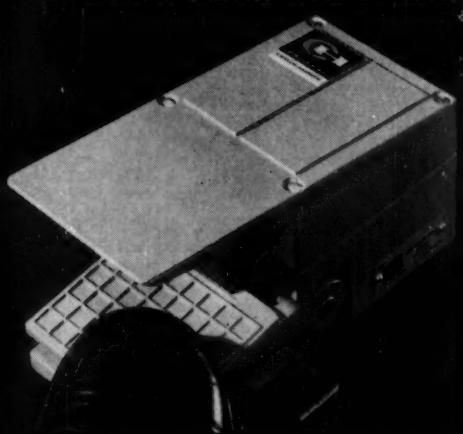
Cutler-Hammer Inc., Milwaukee, Wisconsin • Division: Airborne Instruments Laboratory • Subsidiary: Cutler-Hammer International, C. A. • Associates: Cutler-Hammer Canada, Ltd.; Cutler-Hammer Mexicana, S. A.

Circle 242 on Page 19

HEAVY DUTY SIDE TREADLE OPERATED FOOT SWITCH

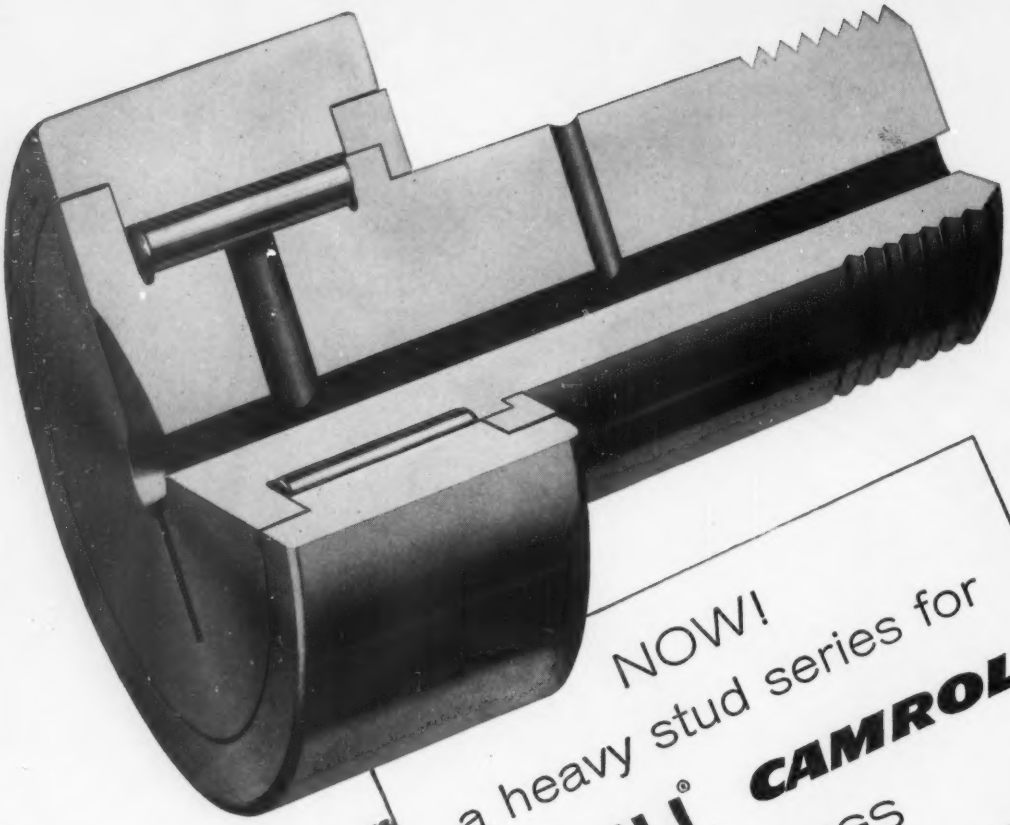
Most versatile foot switch you've ever seen. Just by changing the position of a nylon cam, you can change the operation of the switch on the job. Comes with four nameplates (Start, Stop, Forward and Reverse). Pick the two you want, toss the other two.

HEAVY DUTY TREADLE SWITCH WITH FOOT LOCK Non-slip tread helps keep operator's foot from slipping. Available with several types of guards. Locks when depressed, opens when red release is touched.

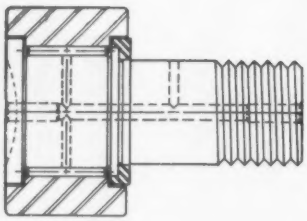


HEAVY DUTY PALM-TYPE SWITCH Big orange surface easy to see. Rated for 600 volts maximum. Neoprene gasket stays flexible, resists effects of oil.

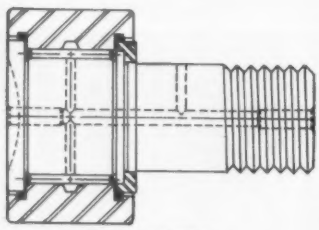
STANDARD DUTY TREADLE-OPERATED FOOT SWITCH Use it for a knee operation. Has a rating of 600 volts maximum. Three mounting bosses permit mounting on uneven surfaces without rocking.



NOW!
a heavy stud series for
McGILL® CAMROL®
BEARINGS



CFH SERIES



SCFH SERIES WITH
INTEGRAL SEALS

with integral seals in a wide range of sizes

These CFH and sealed SCFH series units provide a heavy stud for otherwise dimensionally standard CAMROL bearings. These new McGill cam followers offer increased diameter studs that provide greater shear strength to accommodate excessive stud deflection in critically loaded track, guide, support and cam follower applications.

SCFH series heavy stud CAMROL bearings with integral seals for lubricant retention and protection against contamination are dimensionally interchangeable with the unsealed CFH series.

Both series available from stock in roller diameters from ½" through 4"; larger sizes available on special order in production quantities.

For information and data on the complete line of McGill heavy duty needle roller bearings send for Catalog No. 62.

CONSULT McGILL EARLY
IN YOUR PRODUCT R and D
specialized engineering saves time, improves design

McGILL MANUFACTURING CO., INC.
Bearing Division
200 N. Lafayette St., Valparaiso, Ind.

engineered electrical products
McGILL®
precision needle roller bearings

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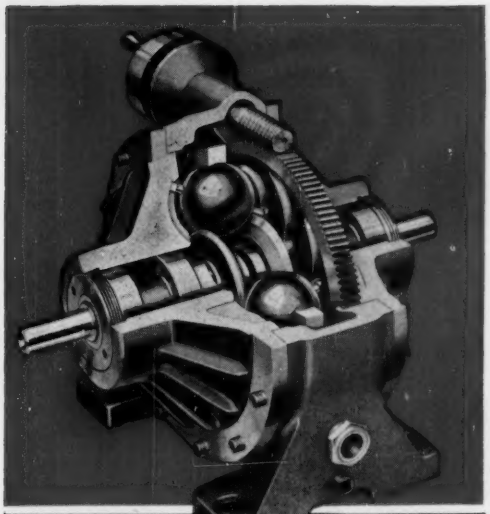
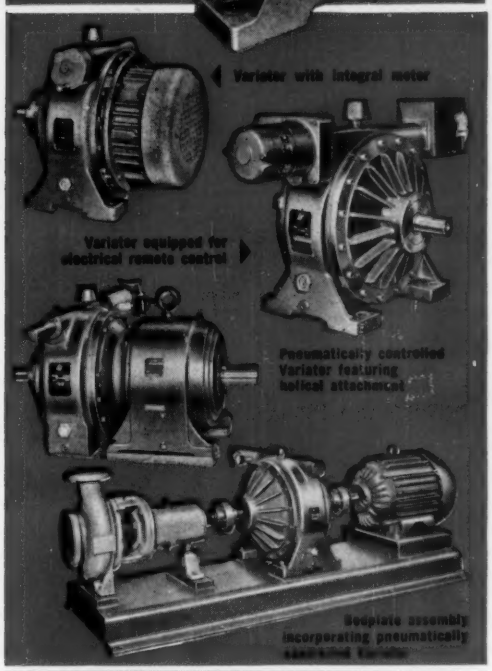



Variator with integral motor
Variator equipped for electrical remote control
Pneumatically controlled Variator featuring helical attachment
Baseplate assembly incorporating pneumatically

for accurate, dependable, infinitely variable speed control, specify...

CLEVELAND SPEED VARIATOR

Cleveland Speed Variators are simple in operation . . . built for long life. Eighteen models—including a new motorized unit—range from fractional to 16 hp at 1750 input RPM. They all accurately provide dependable, infinitely variable speed control over a full 9:1 range—from ⅓ to 3 times input speed. Instant smooth change of output speed can be adjusted by either manual, automatic or remote control. Precise adjustments are always made with accurate adherence to settings.

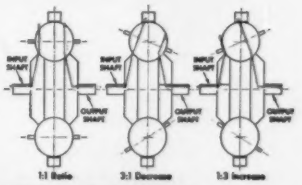
Exclusive Variator advantages:

- An extremely compact unit with input and output shafts in line and rotating in the same direction.
- Almost any input speed up to 1800 RPM can be used—either clockwise or counterclockwise rotation.
- Rated for constant horsepower output over a 9:1 or 6:1 range; or for constant output torque over a 6:1 range.
- Speeds infinitely variable over entire range of adjustment.
- No slippage—positive torque response mechanism adjusts in direct proportion to the loads encountered.
- Long life and minimum maintenance due to absence of belts or complicated linkages.
- Ample bearing support for overhung pulleys on both input and output shafts.

Write today for free Bulletins and Data Sheets shown at left. They contain detailed description, photographs, sectional drawings, rating tables and specifications for the versatile Variator.

Cleveland Worm & Gear Division
Eaton Manufacturing Company
3273 East 80th Street • Cleveland 4, Ohio

Power is transmitted from input shaft to output shaft — rotating in the same direction — through alloy steel driving balls which are in pressure contact with the drive discs. Relative shaft speeds are adjusted by changing position of axles on which the balls rotate.

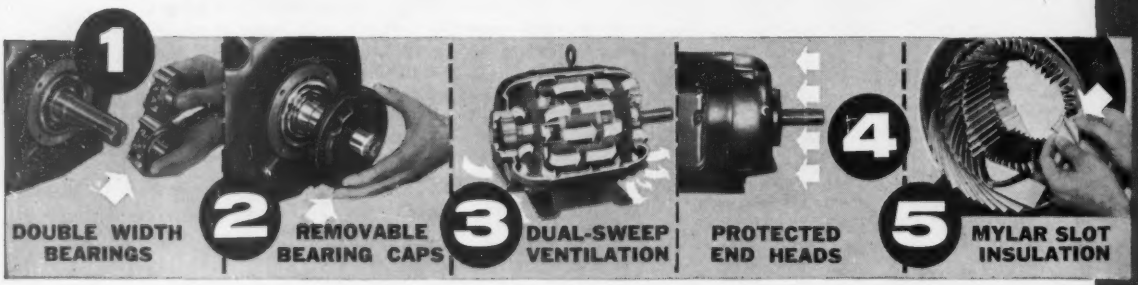


CLEVELAND SPEED VARIATOR

Circle 244 on Page 19

WHICH R&M MOTOR FEATURE WILL ADD MORE TO YOUR PRODUCT'S

COMPETITIVE ADVANTAGE?



All these outstanding features—*yours at no extra cost*—contribute to R&M's dependable performance, easy maintenance and long life. Fully sealed double-width bearings have extra-large reservoirs containing grease selected to resist dust, temperature, humidity and high speeds. Bearing inspection and relubrication are easy. Bearing cap on each end head comes off quickly when four bolts are removed. Bearing seal, held by removable snap rings, is also easily removed. "Dual-Sweep" ventilation greatly prolongs motor life with high-velocity cooling and cleaning. Tandem fans—one pushing, one pulling—create end-to-end ventilation that eliminates "dead" areas. Venturi baffles direct air over and around end coils. One-piece shrouded end heads give full-height protection against moisture and falling objects. Mylar* laminated to rag paper insures positive slot cell insulation because of its excellent dielectric qualities (8 times that of conventional insulation). Rag paper backing provides cushion against abrasion and puncture. Get complete information . . . write today for Bulletin 520-MD

**DuPont registered trademark*

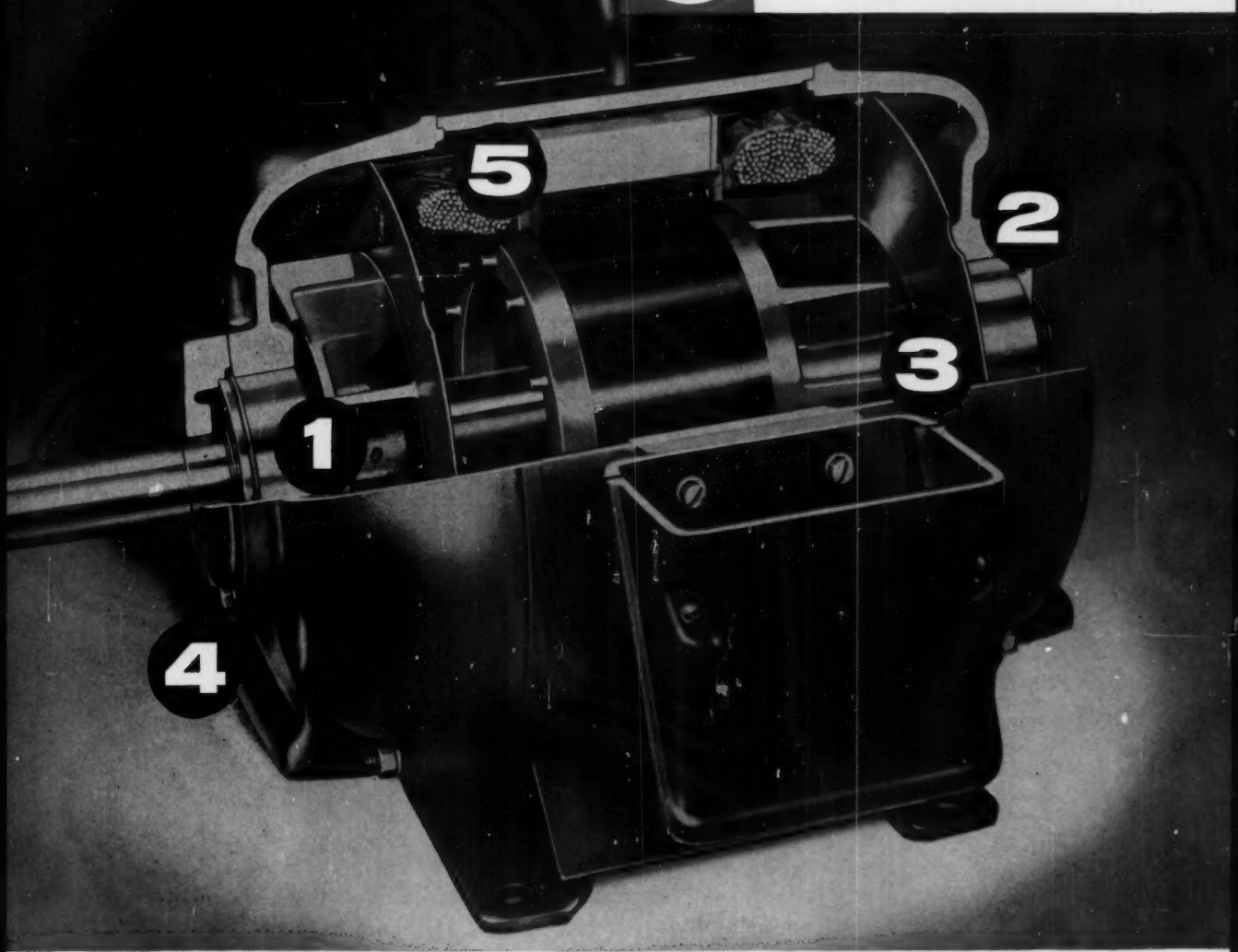
ROBBINS & MYERS, INC., Springfield, Ohio

Fractional and Integral HP Electric Motors • Electric Hoists and Overhead Traveling Cranes • Moyno® Industrial Pumps
Propellair® Industrial Fans • R & M-Hunter Fans and Electric Heat • Trade-Wind Range Hoods and Ventilators
Subsidiary companies at: Memphis, Tenn., Pico Rivera, Calif., Brantford, Ontario.

Circle 245 on Page 19

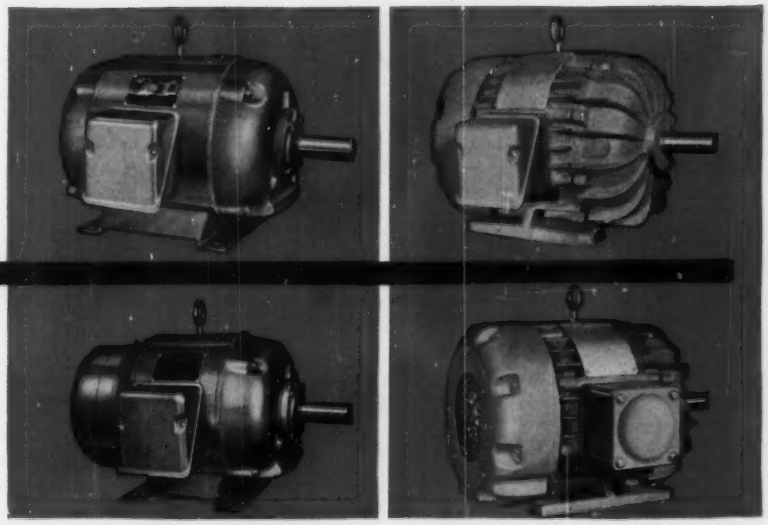
MOTORS 1 thru 200 HP

(other ratings 1/200 to 1 horsepower)



Open Protected Polyphase Motors (left), up to 200 HP, are suitable for many applications formerly requiring totally enclosed construction.

Totally Enclosed Motors (right), ½ to 200 HP, are fan-cooled . . . offer complete protection against all harmful atmospheres.

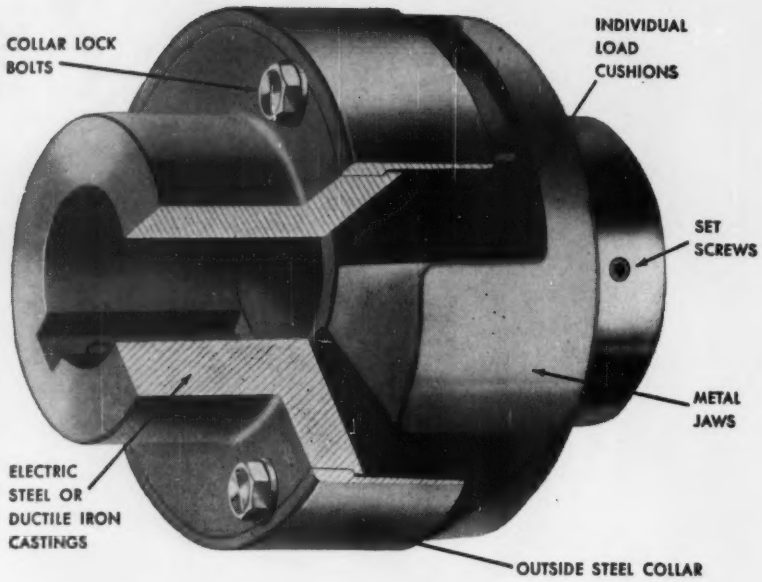


"PM" Single Phase Motors (left), ratings through 20 HP, eliminate maintenance because they are fully weatherized for severe duty.

Explosion-Proof Motors (right), ratings through 200 HP, are Underwriters' Approved for Class I, Group D, and Class II, Groups F & G.

A Report To Equipment Manufacturers

LOVEJOY TYPES C and H FLEXIBLE COUPLINGS UP TO 8500 hp.



Installed and Aligned In Minutes

Just slide on the shaft, bring the jaws together and insert cushions. A twist of the bolts on the outside collar firmly retains the visible cushions.

Alignment is equally simple. Just use a straight edge. Gauges are not required.

Eliminate Trouble and Service Calls

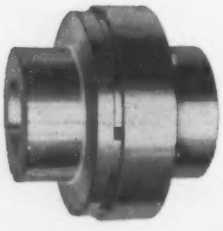
Lovejoy Flexible Couplings contain no intricate parts or mechanisms that require attention or can cause possible trouble. All parts, including cushions, are in plain sight for rapid inspection. Lubrication is never required. Water, oil, dirt or weather will not harm or in any way decrease efficiency.

The best care for Lovejoy Couplings is to *put 'em on shafts and let 'em alone.*

Outlast Equipment Life

Bodies are carefully machined from electric steel or ductile iron castings. The load is entirely transmitted by cushion compression, eliminating metal-to-metal contact and resultant wear on metal parts and jaws.

Even the cushions last longer. First, they are furnished in the material best suited to the service. Second, on non-reversing loads, their life can be doubled simply by reversing or advancing.



Lovejoy Flexible Couplings can be delivered immediately from stock. Heavy-Duty Types C and H run from 18 to 8500 hp. at 1200 rpm. in a wide range of bore sizes. Other sizes and types run from .05 at 100 rpm. to 1020 hp. at 1600 rpm. to provide the most complete selection of couplings available to industry.

Request Catalog A-61 and prices on your company letterhead.

Lovejoy

FIRST NAME IN FLEXIBLE COUPLINGS

LOVEJOY FLEXIBLE COUPLING COMPANY

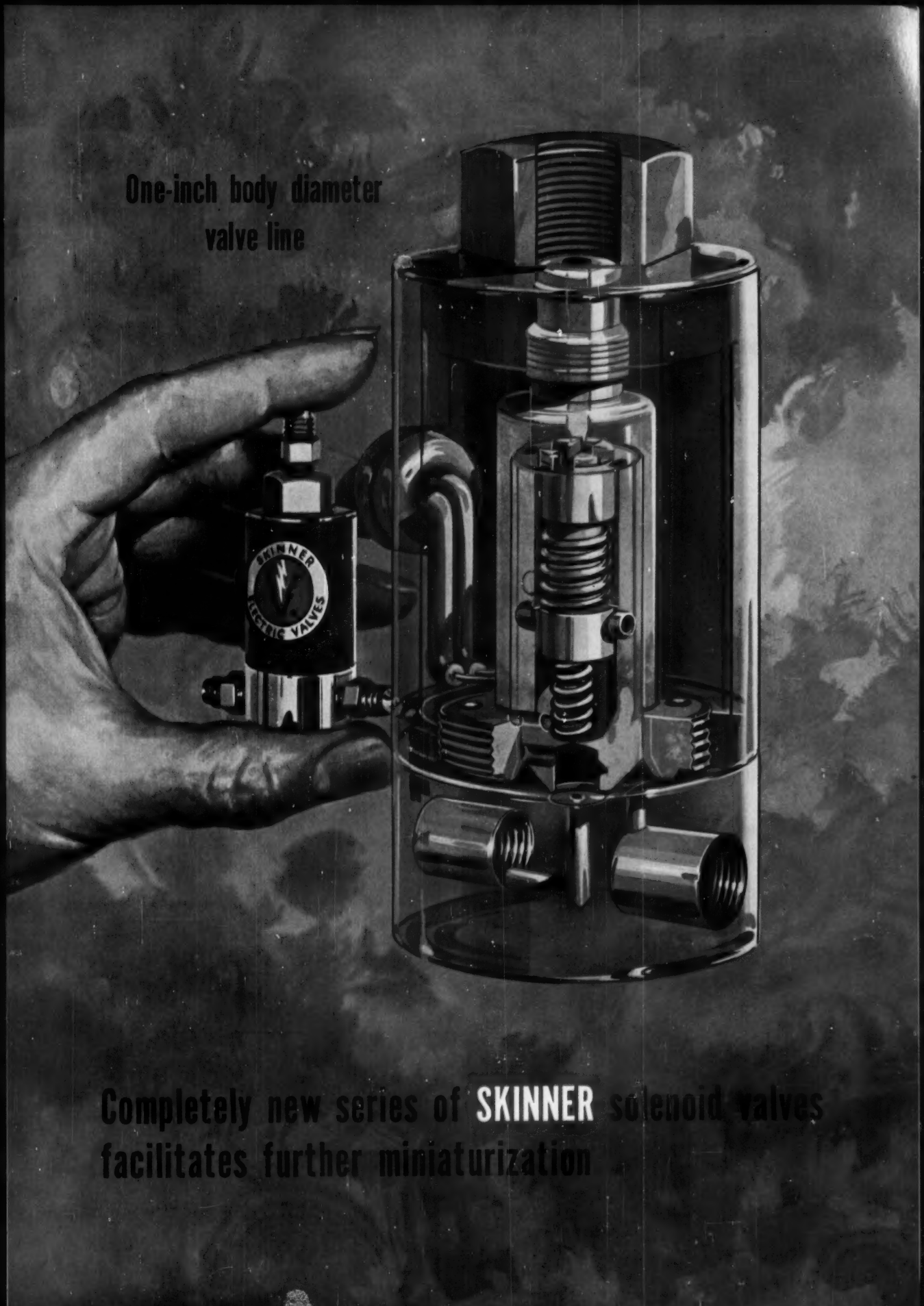
4818 W. LAKE STREET, CHICAGO 44, ILLINOIS

Telephone ESTebrook 9-3010 • Teletype TWX-CG-85

SALES OFFICES THROUGHOUT THE CONTINENT

Please direct inquiries to advertiser, mentioning MACHINE DESIGN

Circle 246 on Page 19→



Completely new series of SKINNER solenoid valves facilitates further miniaturization

Here's a really miniature stainless steel solenoid valve with all the features of a larger valve

think small

VALVE SHOWN ACTUAL SIZE

- Now designers of pneumatic and hydraulic control systems and devices requiring high flow in smaller packages can **specify miniature solenoid valves from shelf stock.**
- These new B Series valves are so small and so new that ⅛" NPT was too large, therefore 1/16" PTF connections were selected. Fittings are included to make fluid connections with ⅛" tubing.
- Never before have there been valves like this—**really miniature in over-all size, pipe size, and weight.**

VITAL STATISTICS

Type	3-way normally closed
Over-all size	1" x 2 1/16"
Orifice size	3/64" Inlet and Outlet
C_v factor	.045
Fluid connections	1/16" PTF (adapted for ⅛" tubing)
Weight	5 oz.
Maximum operating pressure	150 PSI
Vacuum	Down to 5 microns

Skinner Distributors are now stocking the first of these new valves—the three-way normally closed. Three-way normally open and directional control, two-way normally open and normally closed, and higher pressure models will be on the market soon.

For complete information contact a Skinner Distributor listed in the Yellow Pages or write us at the address below.

B SERIES FEATURES

No leakage—Soft, synthetic inserts provide bubbletight sealing. Seats have smooth rounded edges—no cutting of insert material.

Mounting by means of two tapped mounting holes (8-32) in valve body. Can be mounted in any position.

Voltage—Coils available in most AC and DC voltages. Heat rise meets U.L. standard of 85°C maximum for continuous duty. Maximum power requirement—7 watts.

Electrical housings are available with single grommet or ¼" NPT conduit which can be rotated 360°.

Media—B Series valves may be used with all common media including many semi-corrosive fluids.

Corrosion-resistant—Stainless steel body and internal parts.

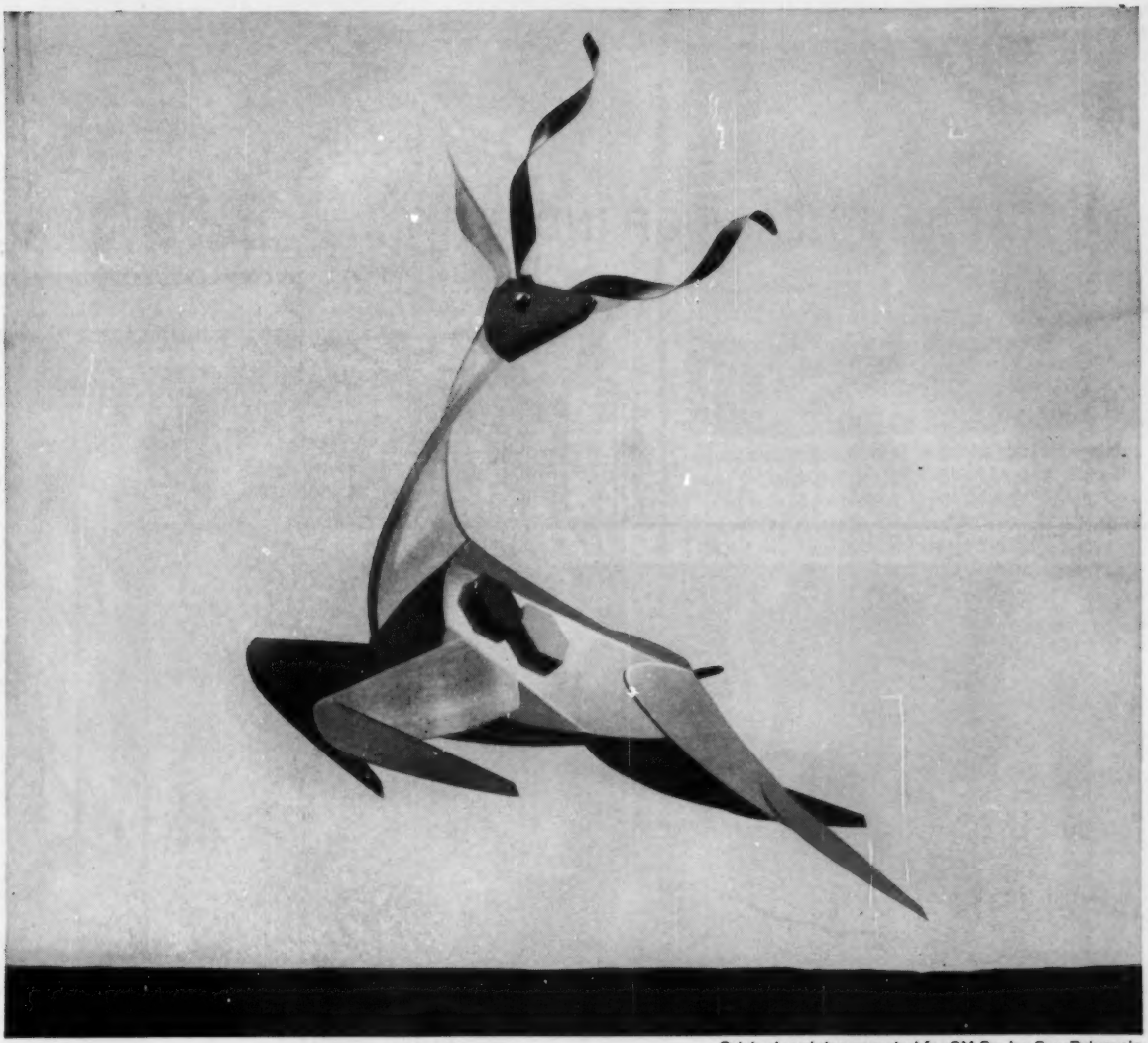
SKINNER ELECTRIC VALVES ®

THE CREST OF QUALITY

SKINNER ELECTRIC VALVES

SKINNER ELECTRIC VALVE DIVISION
SKINNER PRECISION INDUSTRIES, INC. • NEW BRITAIN, CONNECTICUT, U.S.A.

PRINTED IN U.S.A.



Original sculpture created for 3M Co. by Guy Palazzola

Freedom

. . . New design concepts "take off" with 3M Brand Adhesive Products!

Want to escape design limitations imposed by old-fashioned fastening ways? Help yourself to new elbowroom with the modern, clean-lined, functional fastening you get with 3M Adhesives!

New simplicity! Using 3M Adhesives for assembly, you eliminate fasteners, nuts, bolts, rivets, staples. Fewer parts give you simpler construction that costs less, looks better. The making of necessarily complex shapes and castings, too, is simplified by 3M Adhesives; you break down the complex part into several simple sections, then adhesive-bond into one.

New material choices! With 3M Adhesives you bond practically any material to itself or to any other material. Metals (including magnets), woods, glass, ceramics, plastics, the whole works! Lighter gauge materials can be used because adhesives eliminate local stress concentrations, increase joint strength. The integrity of joined materials is unimpaired because holes (for fastening devices) and heat (for fusion) are eliminated.

New production savings! With the increasingly close liaison between industrial designer and production engineer, the many production savings inherent in adhesive bonding favor the design that employs 3M Adhesives. For a realistic appraisal of what 3M Adhesives can do to give you more design freedom, better production economics, call your nearest 3M Field Engineer or write to: AC&S Division, 3M Company, Dept. SBR-91, St. Paul 6, Minn.

"SCOTCH-WELD" is a Reg. T.M. of 3M Co. ©3M Co., 1961

What do you want to bend to what?

The 3M Gazelle is fabricated of these materials and bonded with 3M Adhesives, including SCOTCH-WELD® Brand Structural Adhesives:

1. Brass 2. Wood 3. Plastic 4. Ceramic 5. Copper 6. Stainless Steel 7. Aluminum.

ADHESIVES, COATINGS AND SEALERS DIVISION

MINNESOTA MINING AND MANUFACTURING COMPANY

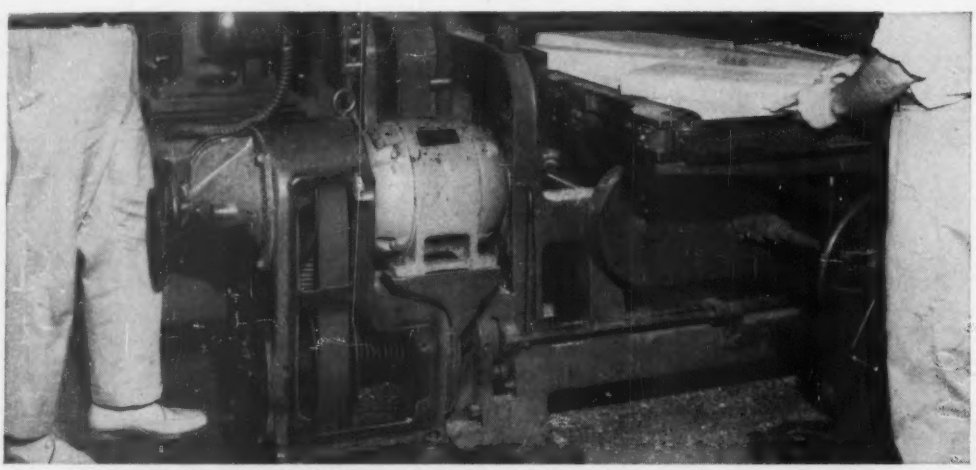
. . . WHERE RESEARCH IS THE KEY TO TOMORROW

3M COMPANY

←Circle 246 on Page 19

Circle 247 on Page 19

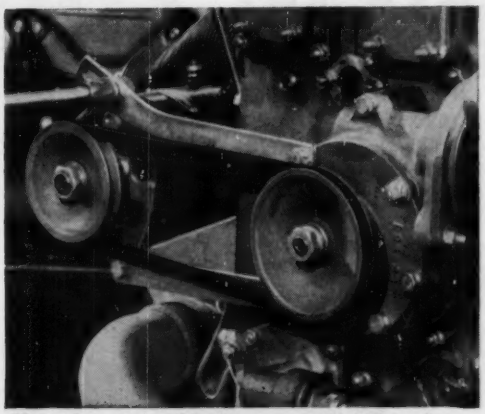
US AT THE HEART OF INDUSTRY...



Making things hum for the world's largest piano manufacturer, this U. S. Royal Variable Speed Belt drives a Whitney double planer 2 shifts a day, 5 days a week at Wurlitzer's De Kalb, Illinois, plant. Installed after a competitive belt failed, this belt requires no maintenance, will last far longer, is non-squashing, non-sagging, completely reliable at speeds of 10 to 2,000 rpm.

VSB 102

Facilitating the transmission of power has long been a major contribution of U.S. Rubber...through industrial rubber products that simplify the design, improve the efficiency, and maximize the reliability of all power equipment. US has, and supplies, the products which make better power equipment possible.

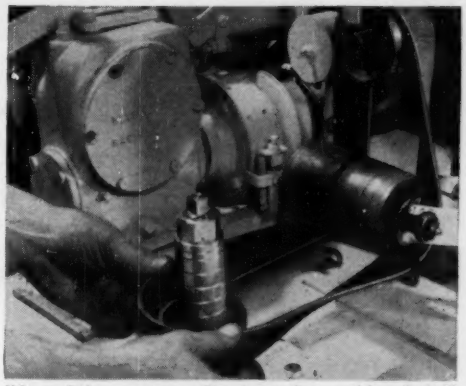


Many thousands of test hours on aircraft engines have demonstrated the remarkable efficiency and stamina of U.S. Rubber V-Belts to Continental Motors. Used to drive the generator on aircraft engines at 4,600 rpms, these belts have excellent length stability, require no maintenance, eliminate many metal parts, and render outstanding service in torque transmission.

VB 108

The revolutionary new flywheel power take-off on Reo's transit-mix truck relies on a U.S. PowerGrip "Timing" Belt for the positive, smooth, direct, and even-flowing power essential to its success. The "Timing" Belt does away with a separate engine or front-end take-off, eliminates the need for lubricants, allows a payload increase of more than 600 lbs. per trip.

TB 106



"One of the most grueling tests for a rubber belt," describes the job of US Flat Belts for Devere Rotary Power Mowers. These belts transmit power from the horizontal motor shaft to the vertical cutter shaft; perform at 3000 rpm while twisting through a 90° angle; must resist dust, dirt, oil, and gasoline. In addition, a U.S. Royal V-Belt propels the power mower.

FB 101

For every industrial rubber product need, turn to US. For Conveyor Belts, V-Belts, the original PowerGrip "Timing"® Belt, Flexible Couplings, Mountings, Fenders, Hose and Packings . . . custom-designed rubber products of every description. Discover why U.S. Rubber has become the largest developer and producer of industrial rubber products in the world. See your U.S. Rubber Distributor or contact US directly at Rockefeller Center, New York 20, N. Y.

WORLD'S LARGEST MANUFACTURER OF INDUSTRIAL RUBBER PRODUCTS

United States Rubber

MECHANICAL GOODS DIVISION

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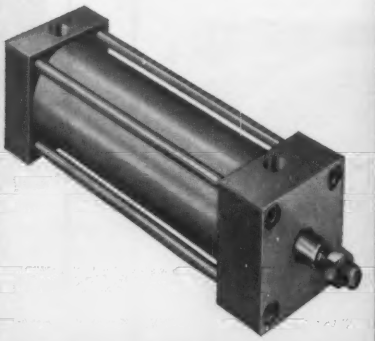
NEW FROM HANNIFIN

A GENERAL PURPOSE AIR CYLINDER

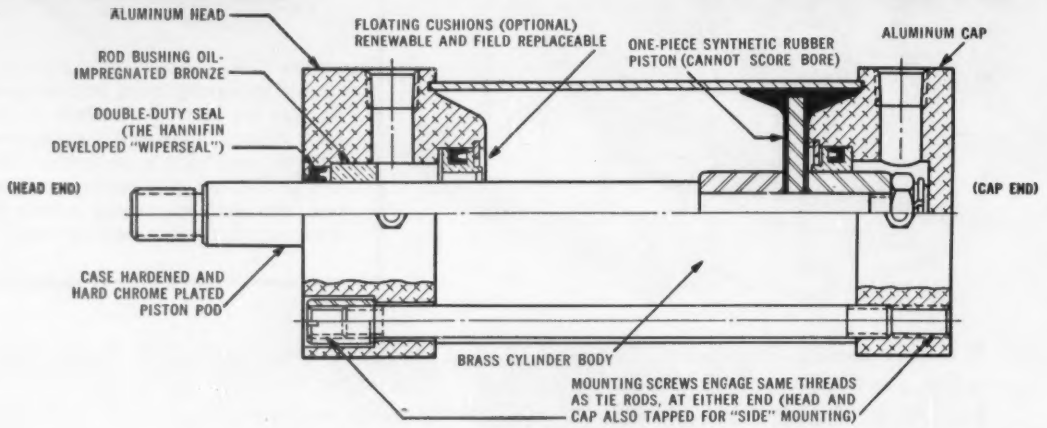
that gives you quality, low cost and mounting versatility

Hannifin announces a new design concept that gives you quality and economy in one package, the new Series "C" air power cylinder with . . .



- One compact basic design that provides side, cap end, or head end mounting without modification.
- Flange, foot or pivot mountings easily made with standard attachments.
- Rust proof construction — brass cylinder body, head and cap of aluminum.
- Cushions that do not change cylinder length — furnished as option or added in field with simple kit.
- An ingenious one piece piston that cannot score the bore — of synthetic rubber, molded around a rugged steel disc.
- Piston rod both case hardened and hard chrome plated, polished to a fine finish for low friction and long seal life. Corrosion resistant.
- Rod bearing an oil impregnated bronze bushing. Minimizes friction.
- Gland seal the Hannifin-developed "Wiperseal" — both a rod wiper and an efficient dynamic seal. It keeps air in, dirt out.
- 5 bore sizes — 1¼", 1¾", 2½", 3⅛" and 4½". Stock strokes from 1" to 20" in 1" increments.

This new Hannifin cylinder design is the latest of the complete Hannifin line of air power cylinders. To help you choose the best Hannifin cylinder for your application, talk to your nearby Parker-Hannifin man. He knows cylinders!


ALUMINUM HEAD
ROD BUSHING OIL-IMPREGNATED BRONZE
DOUBLE-DUTY SEAL (THE HANNIFIN DEVELOPED "WIPERSEAL")
(HEAD END)
CASE HARDENED AND HARD CHROME PLATED PISTON ROD
FLOATING CUSHIONS (OPTIONAL) RENEWABLE AND FIELD REPLACEABLE
ONE-PIECE SYNTHETIC RUBBER PISTON (CANNOT SCORE BORE)
ALUMINUM CAP
(CAP END)
BRASS CYLINDER BODY
MOUNTING SCREWS ENGAGE SAME THREADS AS TIE RODS, AT EITHER END (HEAD AND CAP ALSO TAPPED FOR "SIDE" MOUNTING)

PARKER HANNIFIN CORPORATION

PARKER-HANNIFIN

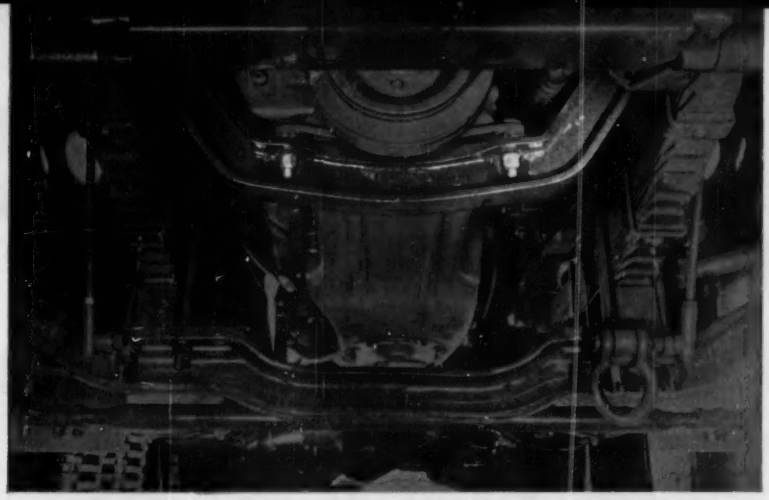
HANNIFIN COMPANY DIVISION

515 South Wolf Road • Des Plaines, Illinois

PNEUMATIC AND HYDRAULIC SYSTEM COMPONENTS

EUROPEAN DIVISION • PARKER-HANNIFIN N.V. • SCHIPHOL • THE NETHERLANDS

Circle 249 on Page 19



For high strength without excessive weight, the designer of this heavy truck chose Tenzaloy for the front engine supporting frame.

Why TENZALOY is the most widely used high-strength aluminum casting alloy

Among high-strength, self-aging aluminum casting alloys, Tenzaloy has won greatest acceptance and widest use by designers because of its unique all-round combination of properties. Outstanding among these special qualities are:

- High yield and tensile strength, combined with adequate ductility
- Exceptional machinability
- Remarkable dimensional stability
- High impact, shock resistance

When Tenzaloy is specified, one big problem is eliminated: heat treatment. Without any artificial thermal treatment, Tenzaloy castings will precipitation-harden at room temperature to give properties normally obtainable only by the expensive solution treating, quenching, and artificial aging of the heat-treatable alloys.

Here are typical properties for Federated Tenzaloy:

Tensile strength	35,000 psi
Yield strength	25,000 psi
Elongation (in 2 in.)	4-5%
Brinell hardness No.	74
Impact strength (Charpy in ft.-lbs.):	
Notched	3
Un-notched	14
Electrical conductivity	30%

Tenzaloy also is corrosion resistant, has superior ductility, and is easily anodized, dyed and polished to brilliant decorative finishes. Castability is excellent in green sand, plaster, investment, shell, oil-bonded sand and precision molds of all kinds. No special techniques are required for handling Tenzaloy in the foundry. Since Tenzaloy has mechanical properties equivalent to such common heat-treated alloys as 195T6, 355T6, 356T6 and 319T6, it can be substituted in applications where any of these heat-treated alloys are presently used.

It is particularly suited to high-strength designs where load carrying capacity and impact strength are essential. For example: frames, brackets, levers, bases, housings, missile ground handling equipment, jet aircraft turntables, explosion-proof enclosures, heavy-duty wheel hubs and cable drums, to name a representative few.

Tenzaloy can widen your design possibilities, increase production efficiency, improve your products, reduce costs. Get complete facts on its physical and mechanical properties by writing for Bulletin No. 103 R5 to: Federated Metals Division, American Smelting and Refining Company, 120 Broadway, New York 5, N. Y.

TENZALOY

ASARCO

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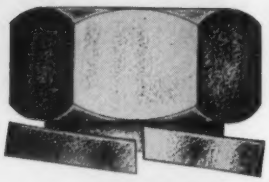
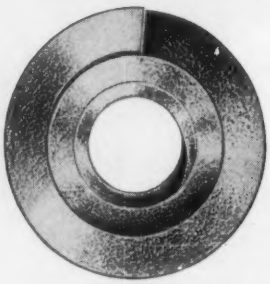
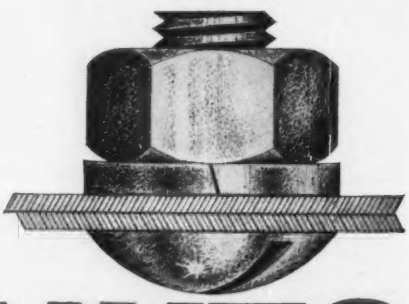
new

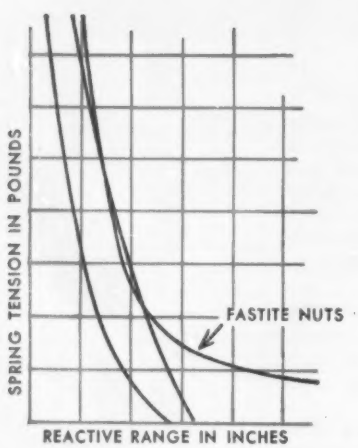






EATON-RELIANCE

FASTITE NUTS



Here is the answer to the growing need by designers and production men for more efficient fasteners on bolted assemblies. The Fastite assembly is a combination nut and helical spring washer, permanently held together, but free to rotate when pressure is applied.

Although it can be applied with equal or better speed than similar fasteners, the biggest advantage of the Fastite nut is the incorporation of the helical spring washer which provides a much greater reactive range and tension than other types of washers now being used.

Of three fasteners tested, the comparative release curve analysis showed the Fastite nut exerted 100 pounds more reactive spring tension when tight than either of the other two fasteners. More interesting, however, from the viewpoint of assembly problems is that the other fasteners lost all reactive spring tension when backed off to .016 inches whereas the Fastite nut still registered 150 pounds. In fact, the Fastite nut still showed reactive tension at .070 inches. The comparative curves are shown at left. A detailed graph of these curves is available for your inspection in the Engineering Bulletin offered below.

Translated into terms of product quality, this simply means the Eaton-Reliance Fastite nut is the best fastener available to reduce the incidence of failure in bolted components due to the ever present problems of bolt stretch and thread wear. Specify Eaton-Reliance Fastite nuts on your next order.

Send for Fastite Nuts Engineering Bulletin, no obligation.

EATON

RELIANCE DIVISION

MANUFACTURING COMPANY

506 CHARLES AVENUE • MASSILLON, OHIO

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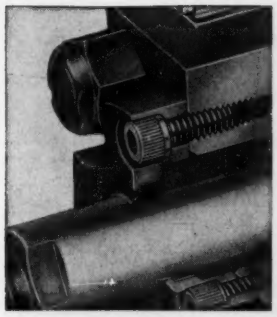
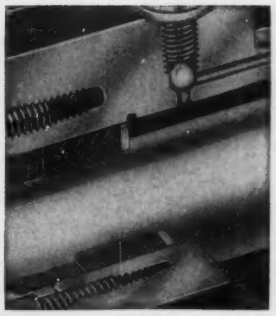
Circle 251 on Page 19

Do the cylinders you buy include these quality features?

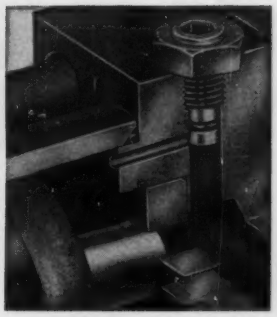


ROD GLAND—Easily removed. No need to loosen tie rods. Cuts maintenance time in half. Phenolic bearing insert will not score rod. Cuts replacement cost to a minimum.

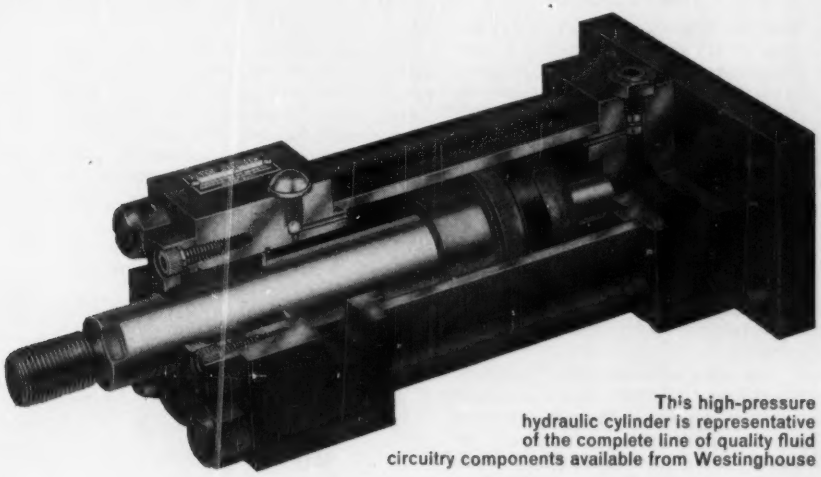


ROD PACKING—Interlocking multiple lip seals require no adjustments; remain flexible under fluid pressure. Wear compensating function eliminates frequent replacement.

PISTON—Phenolic piston will not score tube. Packing cups used for proven long life and seal. Cups are easily replaced. Piston positively locked to rod.



CUSHION—Minimum clearance between piston and Meehanite Bushing combined with micrometer metering give stop cushioning efficiency and a wide adjusting range.



This high-pressure hydraulic cylinder is representative of the complete line of quality fluid circuitry components available from Westinghouse

if not, the chances are, your maintenance costs are higher than necessary. For more information about Quality Fluid Circuitry Controls for trouble-free automation, ask for Catalog A3-56.00.

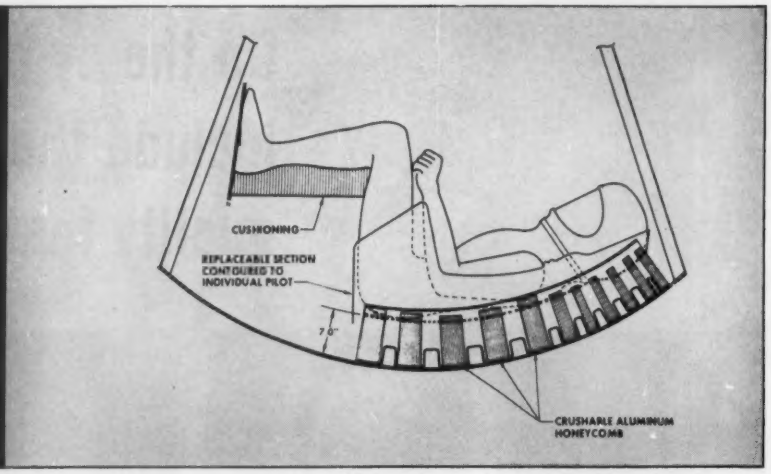
See the Yellow Pages under Cylinders for the Name of Your Local Distributor, or refer to Sweet's Catalog, Product Design File.

WESTINGHOUSE AIR BRAKE COMPANY

INDUSTRIAL PRODUCTS DIVISION, WILMERDING, PENNSYLVANIA

Circle 252 on Page 19

HEXCEL HONEYCOMB ABSORBS 9 G's FOR ASTRONAUT



When Freedom VII opened its parachutes after re-entry, Hexcel crushable aluminum honeycomb absorbed 9 g's deceleration force, to help bring the first U. S. astronaut safely back to earth.

Use of crushable honeycomb for control of forces on decelerating objects is now being applied to such varied tasks as packaging fragile items, providing impact-limiting linkages in landing gear structures and cushioning the impact of air-dropped supplies.

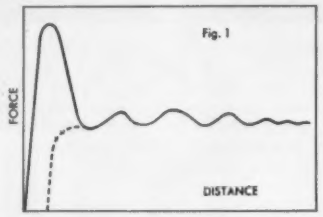
The Problem

Instances requiring impact energy absorption are generally typified by low tolerable deceleration rates for the structure or its contents, high impact velocities, and small maximum allowable stopping distances. Such absorbers as mechanical springs, sponge or solid rubber, foams, cork, and wadding generally exhibit spring characteristics, in that the force transmitted through these absorbers to the object being stopped increases continuously through the distance in which the absorbers contract. In addition, many of these materials do not absorb energy, but merely store it for release as rebound energy.

If an absorber could exert a relatively constant non-rebound force throughout the entire stopping distance, that distance could be shortened, or alternately, the maximum force acting on the object in the same stopping distance could be materially reduced.

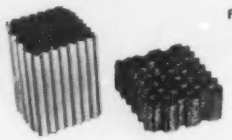
Advantages of Honeycomb

Honeycomb core materials tend to follow such a constant force curve, as shown in Figure 1.



The initial peak on the curve represents the point at which compressive failure begins. This peak can be lowered by prestressing the core to produce slight initial compressive failure. When subjected to further or subsequent loading, the prestressed core proceeds immediately to carry the crushing load, as shown by the dashed line curve in Figure 1.

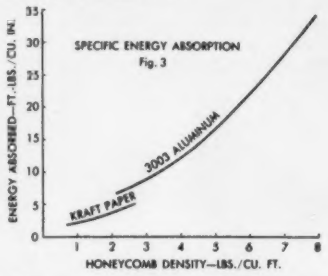
Figure 2 illustrates the appearance of aluminum honeycomb core before and after compressive failure.



By designing a honeycomb core assembly with a specified cell depth this constant force can be applied over a predetermined stopping distance.

Available Materials

These principles apply to aluminum and paper honeycomb, and most similar honeycomb core materials fabricated from ductile metals and fabrics. Figure 3 indicates the general range of energy absorption capacity available in aluminum and paper materials.



These capacities can be further increased by filling the cells with various foamed materials.

Optimum Solution

The choice of materials by the designer will depend upon the particular requirements of the application. But it seems apparent that the utilization of honeycomb offers the optimum solution—in terms of weight and volumetric efficiency—to many types of energy absorption problems.

If you would like further information on the uses of honeycomb for energy absorption or other applications, consult *Sweet's Product Design* catalog or complete the information request at left.

INFORMATION REQUEST

Send to Hexcel Products Inc. Dept. C-9
2332 Fourth Street, Berkeley 10, California.

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Circle 253 on Page 19

National Acme's SL2X limit switch

doubly certified

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Specify National Acme's SL2X . . . and eliminate limit switching problems under explosive conditions. Tested and certified "explosion-proof" by both Underwriters' Laboratories and the Bureau of Mines, the SL2X is specifically designed for use in the mining, chemical, process industries . . . anywhere explosions cannot be tolerated. Latest of National Acme's dependable SL2 "Machine Life" Limit Switches, the SL2X also offers . . . a variety of cam arrangements for extreme operating flexibility . . . ample overtravel (67°) and by-pass (90°) . . . light operating pressure (12½ lbs. at 1½" radius). Get all the details on this new standard of limit switching dependability and safety. Call, write or wire.

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Sales Offices: Newark 2, N.J., Chicago 6, Ill., Detroit 27, Mich.

Circle 254 on Page 19

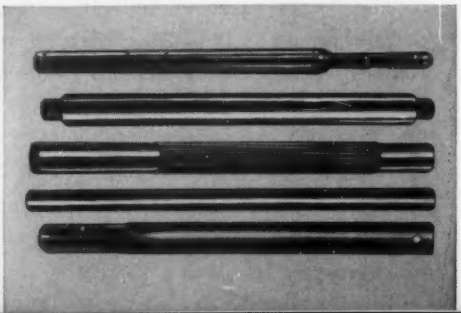
REPUBLIC STEEL...

PROBLEM-SOLVING KNOW-HOW AND EXPERIENCE have made Republic a leader in custom production of Fastener and Formed Parts "Specials." Whenever standard fasteners can't do the job, you'll save time and money by contacting Republic. Write for data on Republic design, engineering, and production services. *Circle 255 on Page 19*

TRIM COLD FINISHED BAR COSTS. Republic's CENTURY SERIES offers five grades of high-strength, stress-relieved, cold finished bars, each with a minimum yield strength of 100,000 psi. For highly machined parts, use C-1144. Moderately machined parts—C-1140 or C-1151. For parts where machinability is a minor factor—C-1050 or C-1045. Send for complete data. *Circle 256 on Page 19*

Steel

Strong, Modern, Dependable



World's Largest Producer of SPECIALTY WELDED TUBING

Challenge us to come up with a solution to your toughest tubing applications.

We will produce the best possible answer drawn from Republic's full line of quality welded steel tubing and more than 50 years of applied engineering experience.

This claim is made with confidence. Our customers regularly hand us their tubing problems, and the results have provided mutual satisfaction.

Manufactured at the Steel and Tubes Division, Republic Tubing is welded by the ELECTRUNITE® process—a continuous electric weld method which unites the wall under pressure without foreign or extra metal. Among other advantages, this process assures uniformity of wall thickness, strength, ductility, and concentricity.

Republic, the pioneer in this improved welding process, was also the first to provide a non-destructive electronic production method of testing tubing used for critical pressure applications. This is known to the trade as FARROWTEST®.

Next time you have a tubing application or problem, take advantage of Republic's prompt delivery, engineering services, and complete range of carbon and stainless steels for mechanical, structural, and pressure uses.

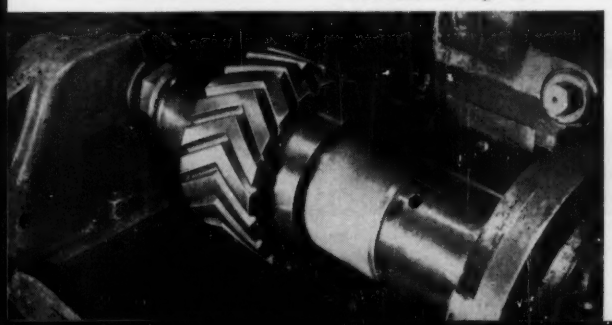
Call your nearest Steel and Tubes representative or contact us direct.

REPUBLIC STEEL

REPUBLIC HAS THE FEEL FOR MODERN STEEL

FOR ADDED MACHINABILITY, consider Republic Cold Drawn Leaded Alloy Steels. Leading producers of gears use Republic Leaded Alloy Steel in the manufacture of heavy-duty herringbone gears. Addition of lead increases machinability as much as 25%. Heat treating assures adequate hardness and toughness. Cost-reducing Republic Alloys are available in almost every standard analysis and many specials. Mail the coupon for information.

Circle 257 on Page 19



Check this listing of Republic Steel Tubing and Pipe. Which have possible applications in your products?

STAINLESS STEEL

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- ☐ Pipe—Schedule 40S
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CARBON STEEL

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Mechanical Tubing

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- ☐ Hot Rolled Tubes
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- ☐ Structural Tubes
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Cut out and send this check list for descriptive literature on Republic Tubing and Pipe applicable to your products.

Circle 258 on Page 19

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Please also send me information on:

- ☐ Republic Cold Drawn Leaded Alloy Steels
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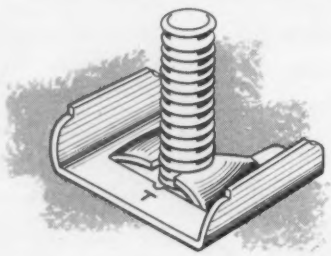
INFORMATIVE NOTES TO IMPROVE YOUR PRODUCT... SAVE YOU MONEY

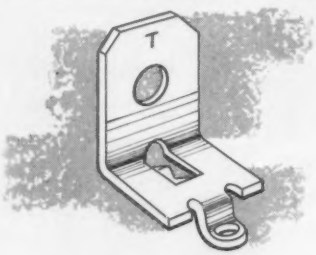
Published as a service to Designers and Engineers

Ideas from Tinnerman have cut costs, improved products. Here are examples from Tinnerman's 10,000 variations of SPEED NUT brand fasteners —all stamped with the T-mark of *total* reliability.

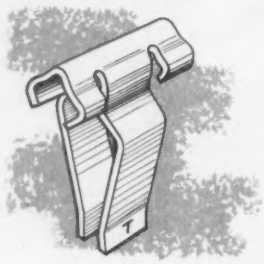
Tinnerman can help *you* cut costs with a free Fastening Analysis of your product. Call your Tinnerman representative, or write: *Tinnerman Products, Inc., Department 12, P. O. Box 6688, Cleveland 1, Ohio.*



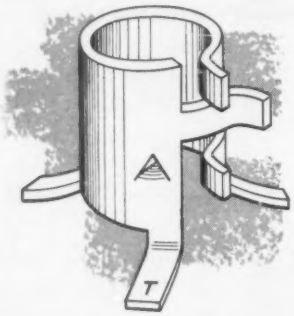
SIDE-SNAP SPEED NUT fastener, originally designed for fastening aircraft templates, can cut assembly time wherever long, threaded rods are used. This heat-treated, spring steel fastener snaps sideways onto the bolt at any point along its length. One turn to tighten and the job is done—*saving the time and cost of running nuts down the length of the long bolt.*



PANEL FASTENER saves welding costs in assembling enameled metal panels on store fronts, filling stations, and homes. This SPEED CLIP® fastener is rotated into self-retaining position in panel hole, then screwed to furring strip, *eliminating six to eight welding operations per panel.* One of many Tinnerman fasteners that cut time and costs in building construction.



MOLDING CLIP retains itself in panel hole until molding strip is snapped on at a convenient station on assembly line. Four spring fingers bear firmly on molding flanges, *prevent rattles due to vibration. Easily removed and reused.* Though originally designed for refrigerator applications, this SPEED CLIP fastener may be used on ranges, air conditioners, metal cabinets, paneling, and dash panels.

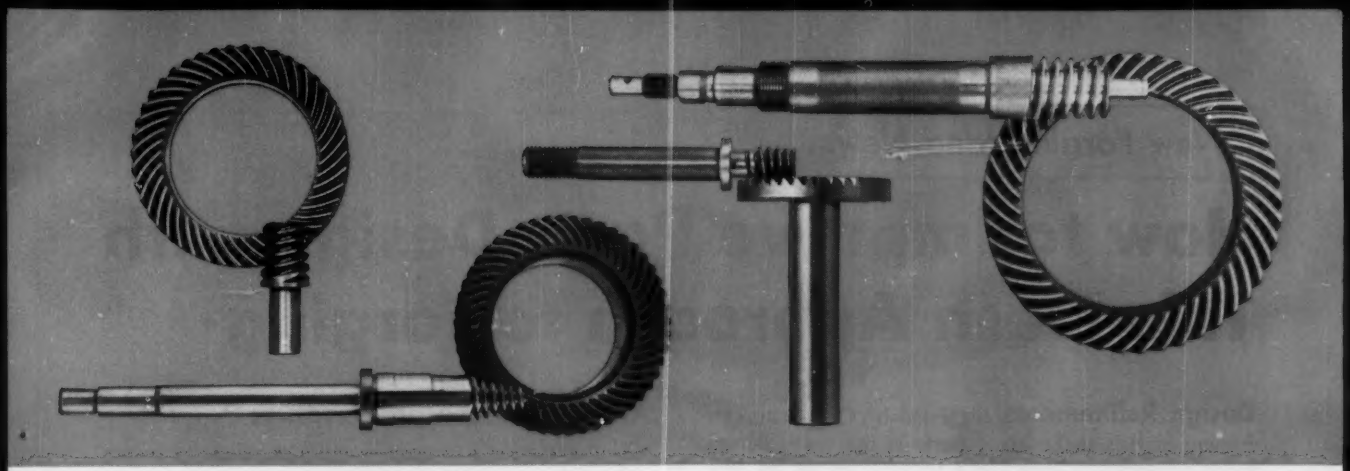


STUD CLIP solves retention problems at minimum cost wherever a .281" diameter plastic stud is used. Four of the SPEED CLIP fasteners *replaced 12 separate parts and four tapping operations* in a clock-radio assembly, and cut assembly time in half. Installation and removal requires only a pair of pliers. Clip offers superior shock absorption.

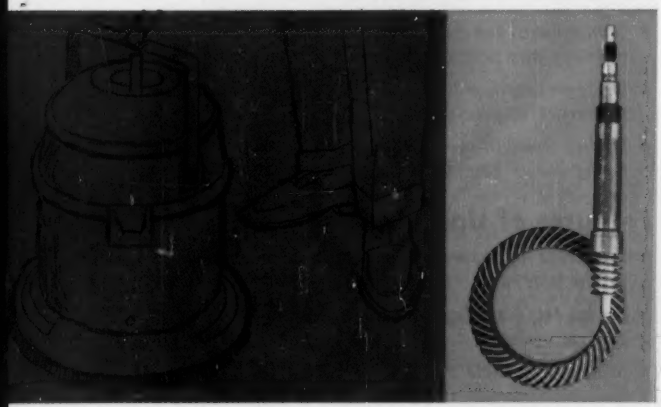
CANADA: Dominion Fasteners Ltd., Hamilton, Ontario. GREAT BRITAIN: Simmonds Aerocessories Ltd., Treforest, Wales. FRANCE: Simmonds S.A., 3 rue Salomon de Rothschild, Suresnes (Seine). GERMANY: Mecano Simmonds GMBH, Heidelberg.

TINNERMAN
Speed Nuts®
Look for the Tinnerman "T"

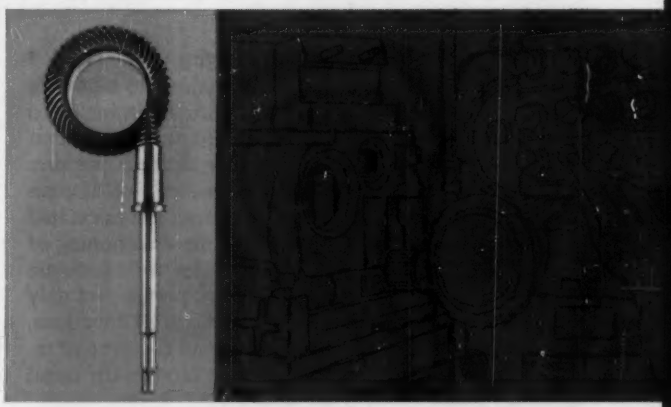
Circle 259 on Page 19



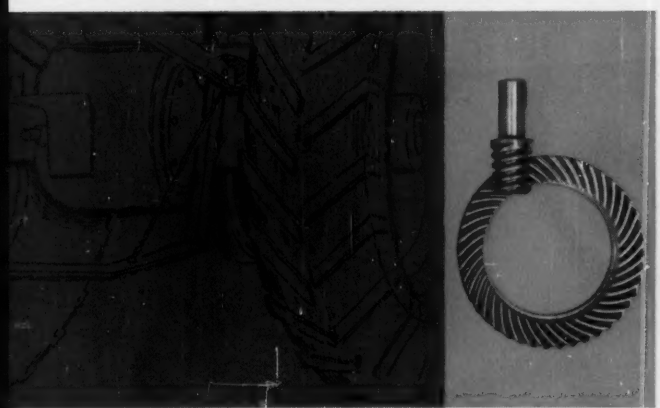
WHICH OF THESE HIGH-RATIO HYPOIDS IS "JUST RIGHT" FOR YOUR PRODUCT?



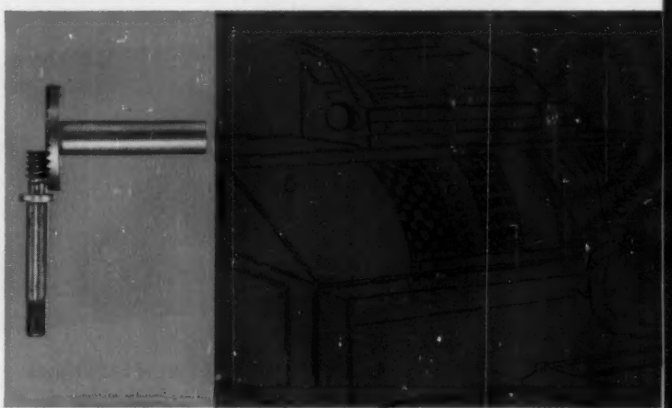
For hand tools. Where space is a problem—as in portable tools like this one—the high offset lets you design a more compact unit. Choose just the offset to solve your design problem with a more flexible, more compact unit than the corresponding worm and wheel.



. . . or machine tools. This high-offset pair lets you combine high reduction with strength, compactness and other advantages you might find profitable in designing machine tools. High-ratio hypoids can be produced on Gleason equipment for ratios of 1:10, 1:40 or even higher.



Big and strong. Where you need strength—as in farm machinery—high-offset hypoid pinions (with teeth which tend to "wrap around") are larger and stronger than corresponding bevel pinions. An extended shank on cylindrical pinions makes very rigid straddle mountings practical.



. . . or small and smooth. For smooth operation—as in office equipment that must run quietly—high-offset pairs provide smooth, quiet tooth action. Because teeth "wrap around" the pinion, you get continuous action—even with just one or two teeth! Grinders are available for applications requiring precision finish.

High-offset or high-ratio hypoids can be cut, tested, and quenched on the same Gleason equipment that is used on more familiar spiral bevel and hypoid gears. You can get more information about Gleason high-ratio hypoid gears by writing for free literature. Submit your prints for recommendations.

GLEASON WORKS

1000 UNIVERSITY AVE., ROCHESTER 3, N.Y.

Circle 260 on Page 19

New Forging Idea News

How to Improve Parts Design with This Fresh Approach to Forging

Design Refinements suggested by COMMERCIAL'S forging experts make many parts in use today better, more economical. Here are detailed examples of only three COMMERCIAL upset forgings which demonstrate how these design refinements have resulted in superior OEM parts at lowered cost.

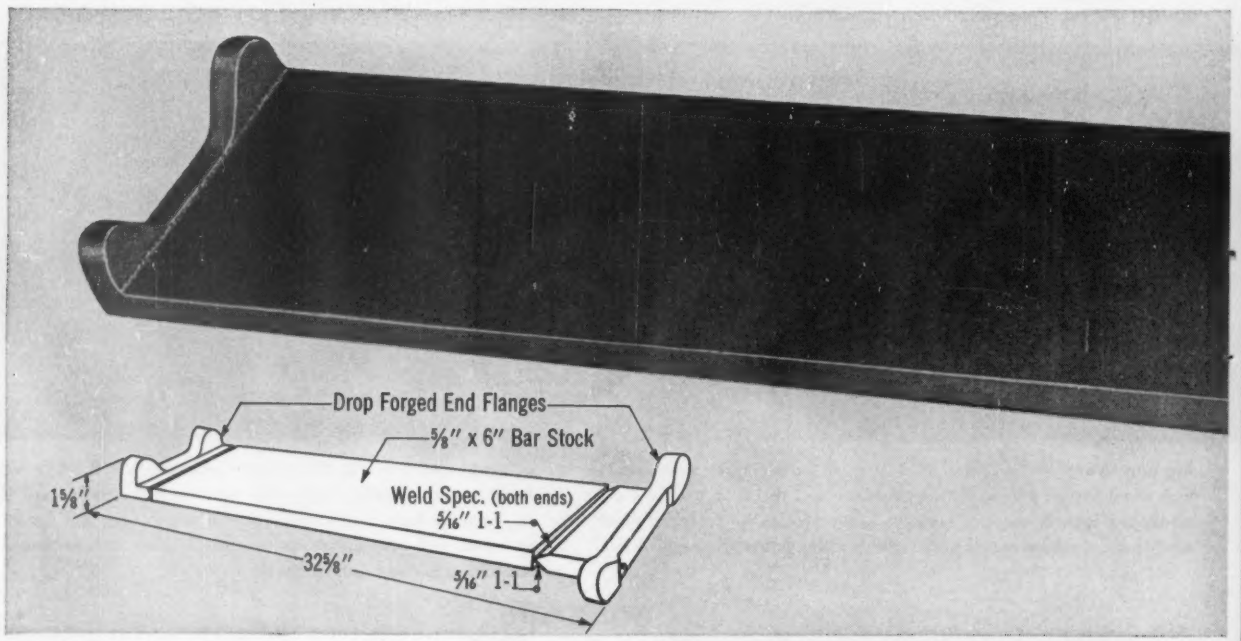
Quality Forgings start with "Forging Quality" rolled steel... closely controlled in its making to eliminate defects, to obtain surface and interior soundness, to refine grain structure into a directed fibrous flow. Upset Forgings in closed dies produces by squeeze pressure a "looped" grain flow and permits concentration of grain density at points where the service stresses are calculated to be the greatest. Also, control of the directioning of the inherent fiber-like structure provides for maximum strength of the metal at required stress points. Not only are the properties of the metal improved in all directions, but also the metal structure is refined and compressed resulting in a structural uniformity that renders the metal remarkably free from concealed defects. Result: Tough, strong part—free of hidden defects and surface flaws.

Advantages of Upset Forgings

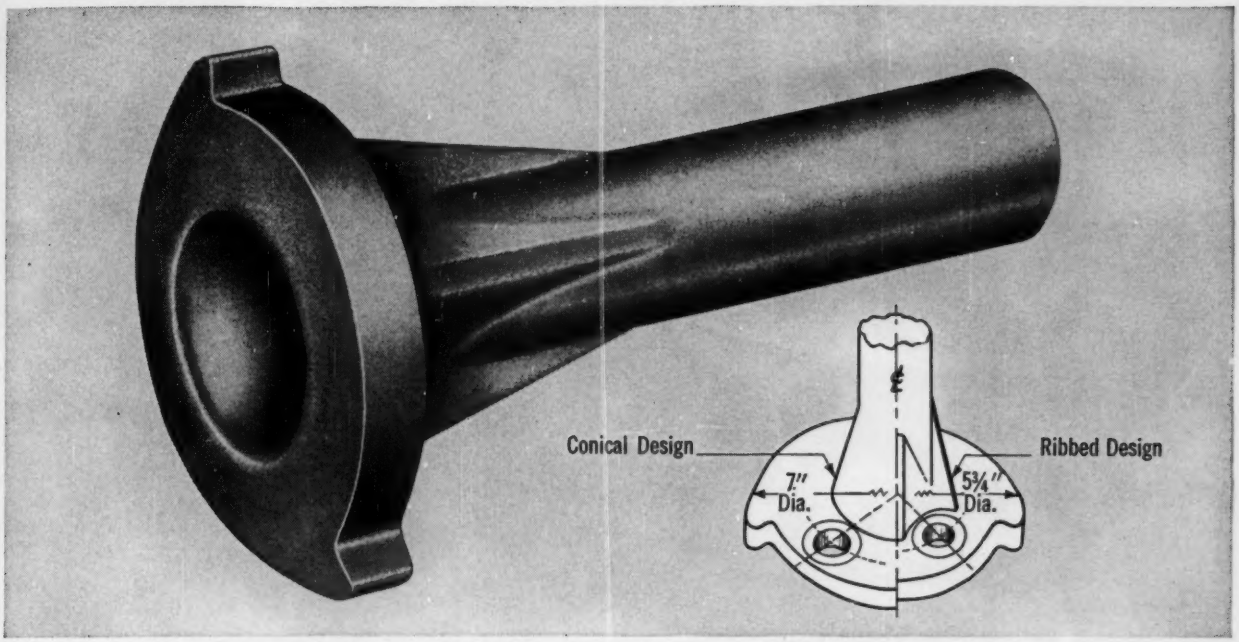
- *Uniform strength, toughness and high fatigue resistance insure longer, more dependable service life for equipment.*
- *Parts made closer to finished dimensions—cuts scrap, reduces machining and finishing time.*
- *Components can be assembled by simple production methods into complex parts.*
- *Uniform response to heat treatment gives desired physical properties of precise degree.*
- *Higher strength-to-weight ratio obtainable—a vital factor in the design complexity of parts for the future.*

Features of Upset Forging by COMMERCIAL

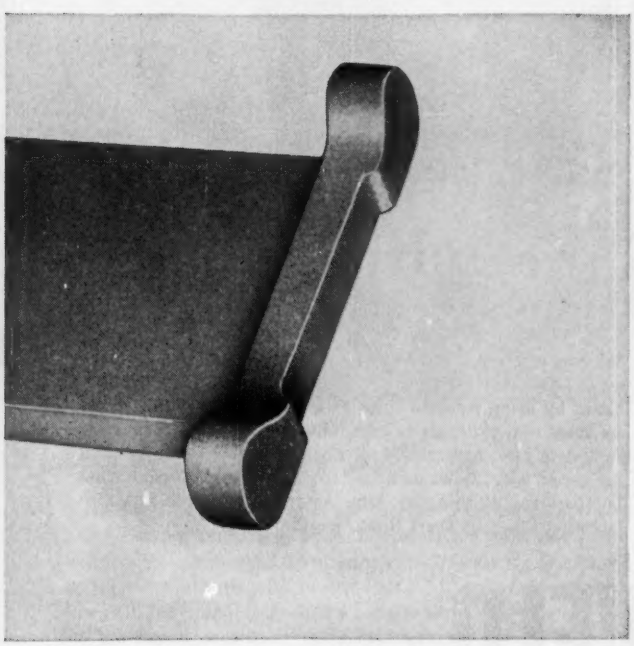
- *Batteries of upsetters from 1½" to 8"—custom or production runs.*
- *Hydra-Jet descaling prior to forging reduces imbedded surface scale.*
- *Magnetic particle depth inspection to detect metal faults before shipment.*
- *"Task Forging" team steeped with experience in producing the unusual upset forging.*



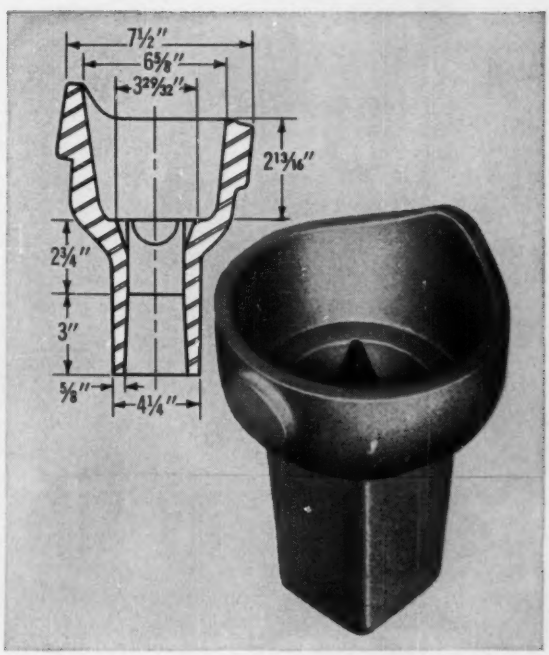
FORGING REPLACES WELDMENT—Structural side bar for agricultural tractor was formerly fabricated from ⅝" x 6" mill-edge bar stock and two drop forged end flanges. COMMERCIAL'S redesign called for a homogeneous "metal quality" upset forging. Controlled, fiber-like grain structure is concentrated at stress points. All welding and grinding is eliminated. Warpage disappeared and surfaces are smooth ready for final high lustre finish. Except for automated drilling of holes, now possible due to close tolerance forging, the part is ready for assembly line. Customer benefits have decisively proved the advantages of COMMERCIAL'S "Task Forging" team know-how.



FRESH APPROACH DESIGN SAVES 25%—Lower front end steel tractor spindle, if produced to conventional design, presented excessive weight problem. Symmetrical conical taper from shank to cam head called for 45 lbs. blank weight. COMMERCIAL produced the part to the ribbed taper design with 34 lbs. blank weight. Here is an excellent example where closed die forging most efficiently positions quality metal. Even the cam ears were upset to exact size and location. Result: Smaller part with ample strength, important cost benefits.



While designs are on the board, call on COMMERCIAL's "Task Forging" team to collaborate with you. Many other ingenious solutions by COMMERCIAL to tough forging problems are detailed in Bulletin 600-P1. Write Commercial Shearing & Stamping Company, Dept. S-39, Youngstown 1, Ohio.



UNIQUE FORGING SUPPLANTS CASTING—Unusually shaped axle trunnion socket seemingly was a natural for casting because of a symmetrical trunnion end plus external boss. COMMERCIAL produced the part to finished size via closed dies in an 8" upsetter. Metal had to be displaced both internally and externally. Result: Rejects cut way down, less machining, stronger part, weight reduced, metal saved.

When it's a vital part, design it to be FORGED

COMMERCIAL shearing & stamping

Save on any size rings with Amweld

Amweld makes flash butt-welded rings in diameters of four inches to eight feet and offers ring customers a sizable cost reduction in every case. Amweld rings save on metal, because rings are formed to or near finished dimensions. Amweld rings save on machining, because the metal is left out—not hogged out. Important to you, Amweld can flash weld rings from almost any metal alloy, common or exotic.

Savings to all Amweld customers totaled over one million dollars last year. One Amweld customer saves by using Amweld rings as gear blanks. Another saves by using Amweld rings as tank flanges. A third saves on rings for jet engine applications. It doesn't cost a thing to think on paper with Amweld. So let us quote you for your cost comparison. Write today: The American Welding & Manufacturing Co., 901 Dietz Road, Warren, Ohio.

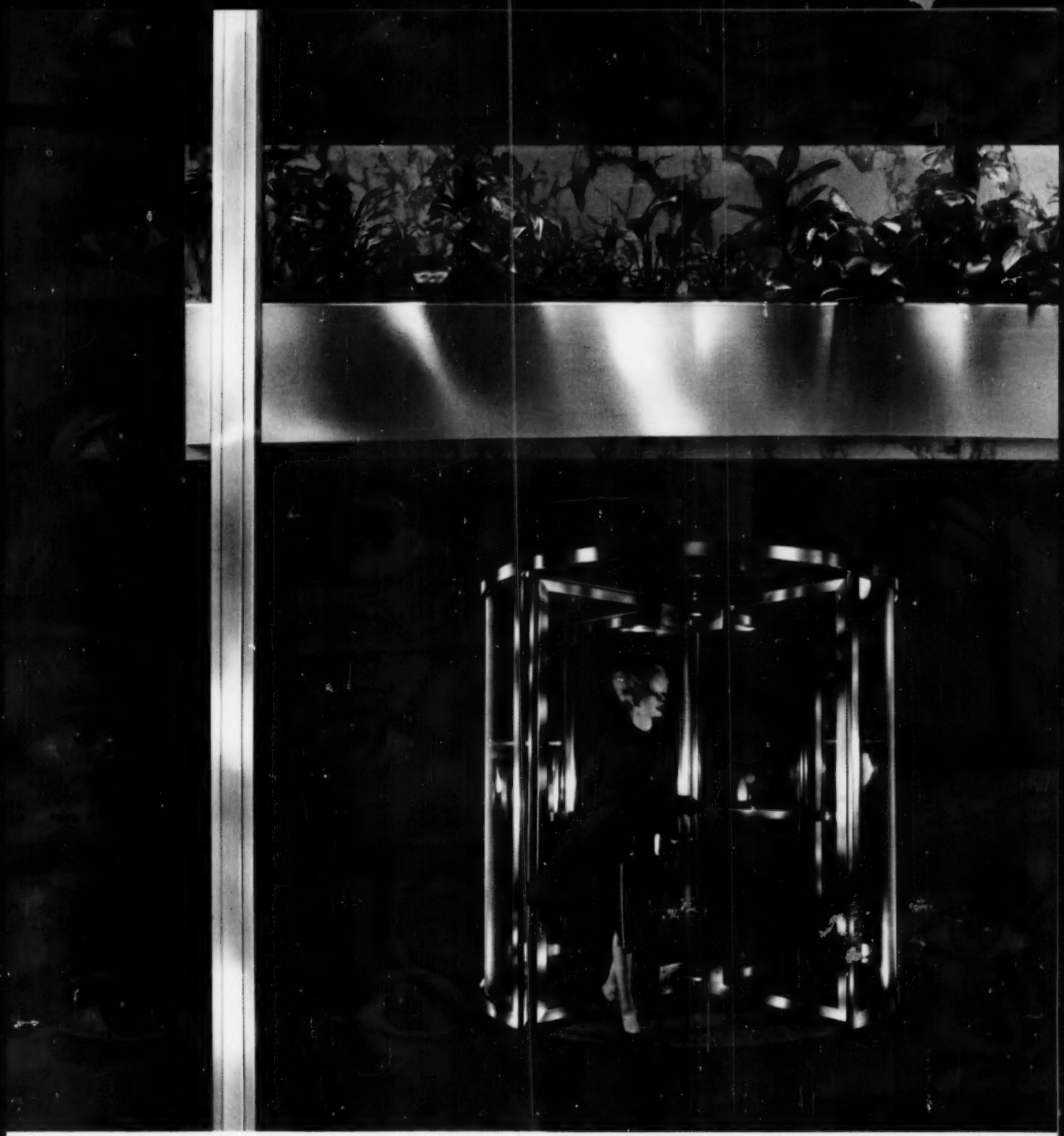
AMWELD®

INDUSTRIAL PRODUCTS

THE AMERICAN WELDING & MANUFACTURING CO., WARREN, OHIO

Circle 262 on Page 19

Circle 263 on Page 19→



Duration of a first impression

Stainless steel has its own beauty secret. What meets the eye today will be unchanged 20 or 30 years from now, the finish still flawless, unmarked by wear or corrosive air. Unlike some architectural metals with beauty that is only skin deep, stainless will last indefinitely—with little or no maintenance.

Time-tested, consistent product performance like this comes from consistent quality materials—and J&L leads the stainless steel industry in melt shop standards, the point where quality starts. That is why J & L stainless, in a variety of finishes, is widely used in all types of buildings, inside and outside, wherever a first impression—and a lasting impression—is important.

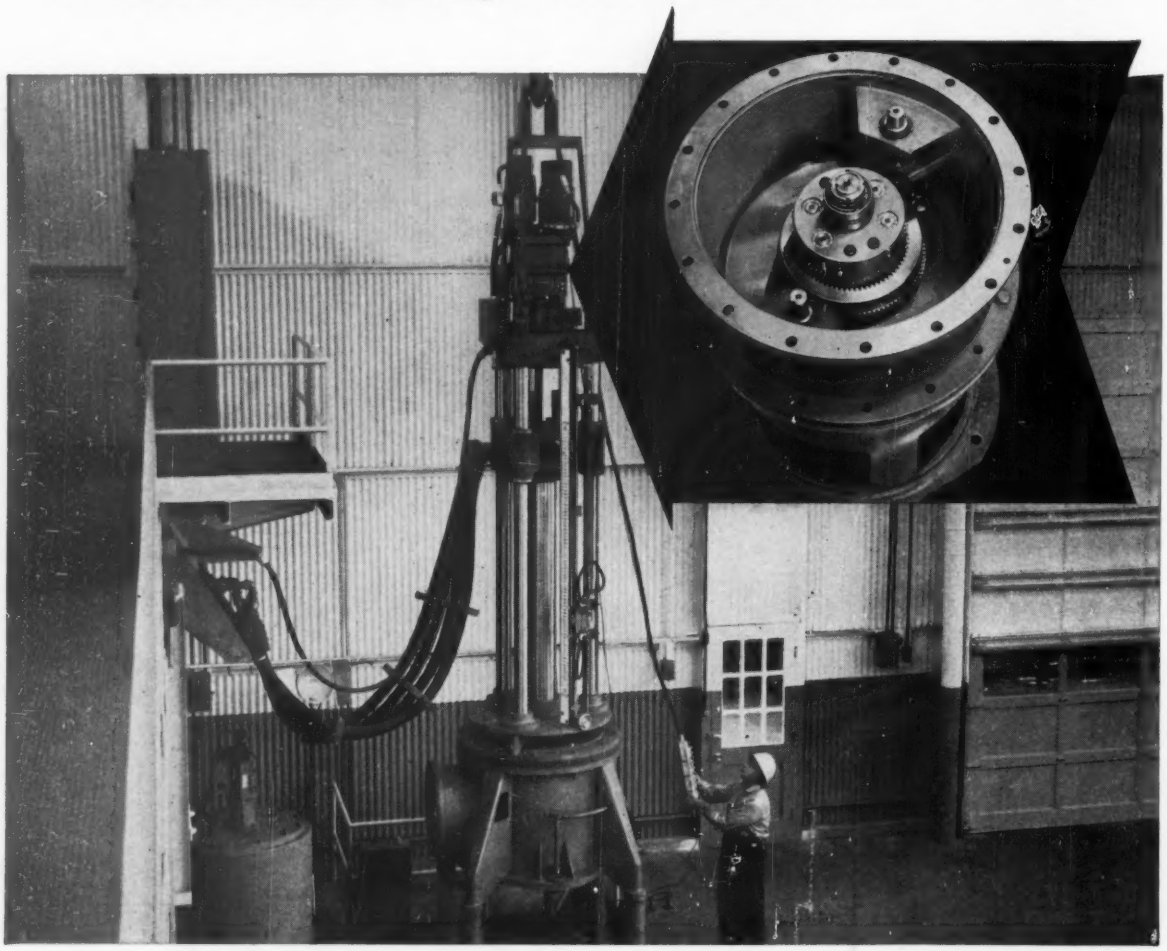
Your J & L distributor can provide the technical assistance and the consistent quality stainless steel you need, backed by the consulting services of J & L's architectural department.

Jones & Laughlin Steel Corporation

STAINLESS and STRIP DIVISION • BOX 4606 • DETROIT 34 • MICHIGAN

J&L STAINLESS
SHEET • STRIP • BAR • WIRE

Philadelphia Precision Ground Gearing Increases Sensitivity of New Vacuum Arc Furnace



Philadelphia precision ground gearing is responsible for smoother, more efficient operation of a new consumable electrode vacuum arc melting furnace installed at Standard Steel Works Division of Baldwin-Lima-Hamilton Corporation.

This specially designed differential reduction, planetary gear drive greatly increased the efficiency of the furnace. The old problem of stop-start action with uneven electrode burnoff has been completely eliminated. Now, uniform electrode feed permits arc voltage to be maintained within ±.1 Volt. Electrode burnoff is uniform.

This drive problem is typical of hundreds that have been solved with Philadelphia hardened, precision ground gearing . . . problems where improved gear accuracies have resulted in space and weight savings, higher-speed operation, reduced sound and vibration levels, and longer gear life—all at no increase in cost.

Our experienced engineering staff, specialists in all types of power transmission problems, make sure that proper design and materials combine to meet your most exacting needs.

For more complete information, write on your company letterhead for our Catalog: AN ADVANCED CONCEPT IN MODERN GEARS.

philadelphia gear drives

PHILADELPHIA GEAR CORPORATION

King of Prussia (Suburban Philadelphia), Pennsylvania

Circle 264 on Page 19

HOW TO HANDLE 3 Basic Timing Functions With ONE HAYDON CONTROL

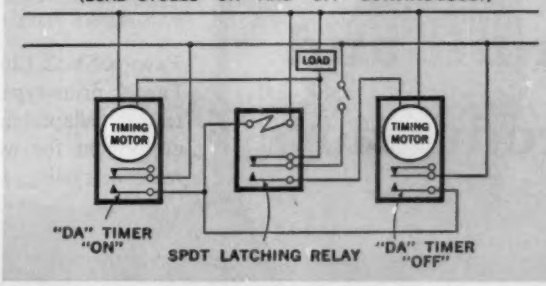
Haydon Series DA Time Control Performs All Basic Timing Functions with Simple Timer and Relay Set-ups . . . Saves You Money, Simplifies Your Engineering.

This reliable, *low cost* timing device easily adapts to hundreds of applications, avoiding the need for custom-built timers.

The Haydon Series DA Time Delay Timer is designed around a motor with a magnetically operated clutch. When the motor is energized, the clutch is engaged and the motor shaft drives an arm which . . . at the end of the desired interval . . . actuates a switch. When the motor is de-energized, the clutch disengages, permitting the arm to be reset by a spring.

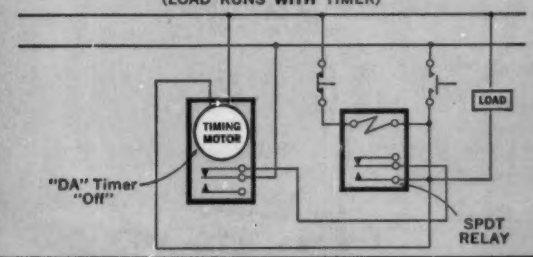
CYCLE TIMING: *(with 2 Timers, 1 Latching Relay)*

(LOAD CYCLES "ON" AND "OFF" CONTINUOUSLY)



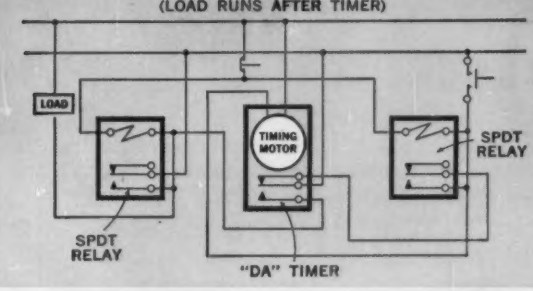
INTERVAL TIMING: *(with 1 Timer, 1 Relay)*

(LOAD RUNS WITH TIMER)



TIME DELAY TIMING: *(with 1 Timer, 2 Relays)*

(LOAD RUNS AFTER TIMER)



DA-11 — Hand set dial reading in seconds. Long terminal board; ranges up to 4.5 minutes.

DA-21 — Lock wrench set dial reading in percentages. Short terminal board; ranges up to 9.5 minutes.

SPECIFICATIONS

Switch Ratings — SPDT 20 amps, 125 or 250V ac resistive load. Maximum inrush: NC contacts 30 amps, NO contacts 15 amps. Switch capable of handling small fractional horsepower motors and components meeting these specifications. Other switches available.

Timing Motor Voltages — 120 or 240 volts, 50 or 60 cps.

Delay Ranges — Time delay of 0 to 14 seconds, 0 to 57 seconds, 0 to 4.5 minutes, 0 to 9.5 minutes.

For details on DA Series Time Controls, write to:

TIMING MOTORS
TIME AND TORQUE CONTROLS

HAYDON

DIVISION OF GENERAL TIME CORPORATION

3133 EAST ELM STREET
TORRINGTON, CONNECTICUT

Circle 265 on Page 19

in design or modernization of small-horsepower machines...

Fawick small clutch applications increase profit and production

. . . through low unit cost

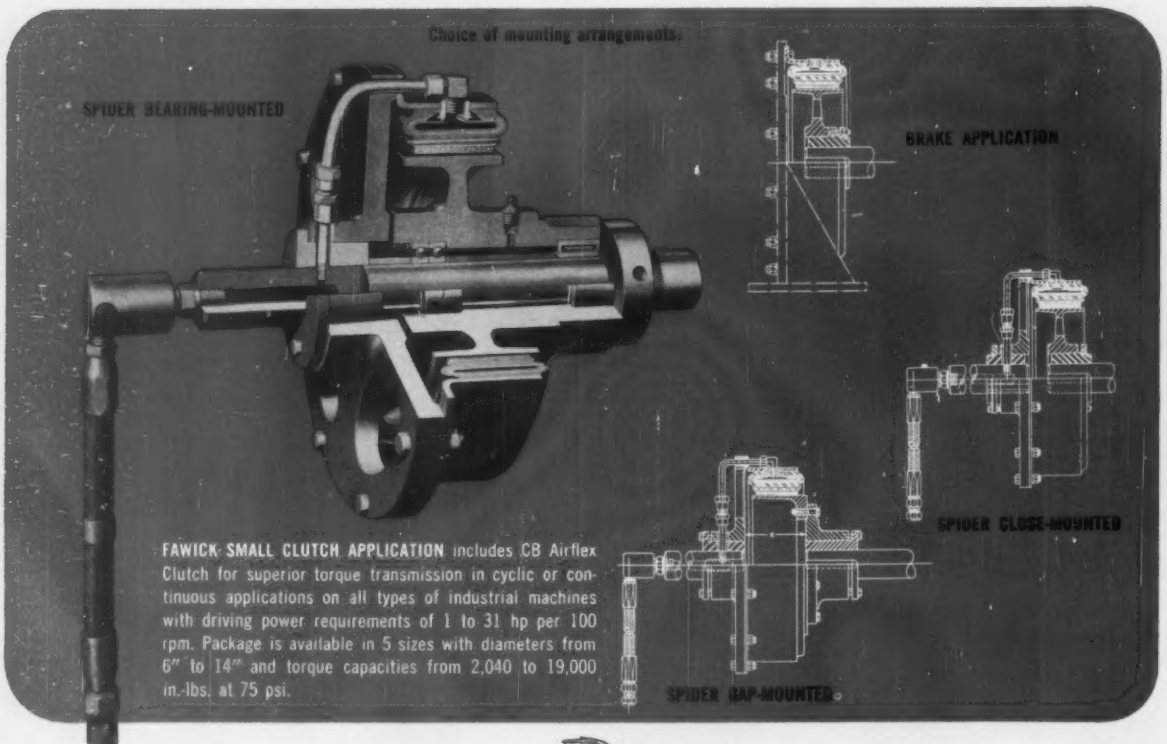
FAWICK Small Clutch Applications are standardized air clutch packages, produced in volume, and priced low for economical design or modernization of cyclic machines with small horsepower requirements.

. . . low installation cost

Complete FAWICK adaptability, with standardized bores and mountings, assures simplified installation in through-shaft, clutch-coupling and brake applications.

. . . and improved machine performance

FAWICK Small Clutches incorporate all the operating advantages of Fawick drum-type air clutches—instant engagement, overload protection, adaptability to local or remote control, automatic self-adjustment for wear and low maintenance. These permit faster machine cycling, greater precision, higher productivity.

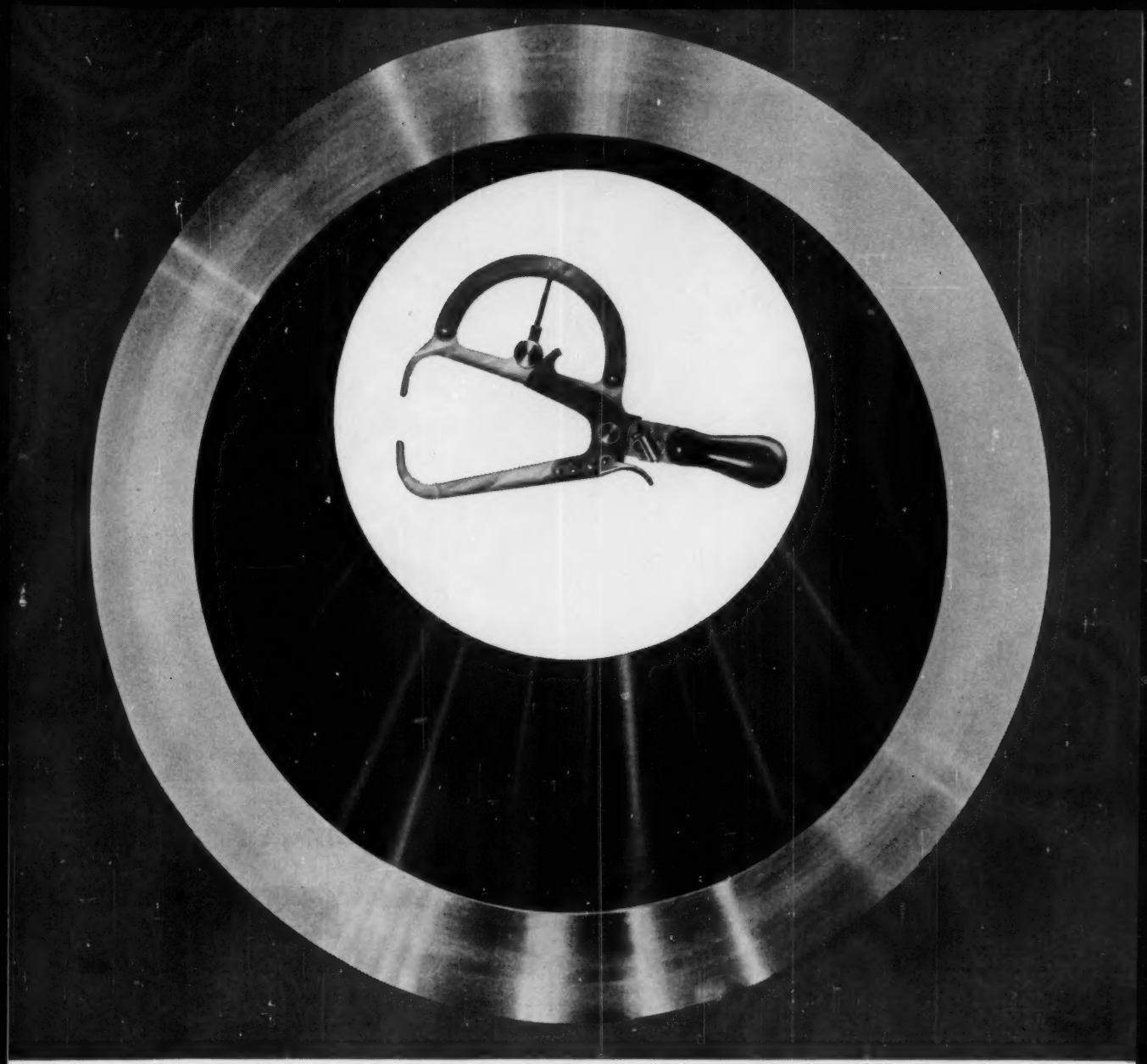


FAWICK SMALL CLUTCH APPLICATION includes CB Airflex Clutch for superior torque transmission in cyclic or continuous applications on all types of industrial machines with driving power requirements of 1 to 31 hp per 100 rpm. Package is available in 5 sizes with diameters from 6" to 14" and torque capacities from 2,040 to 19,000 in.-lbs. at 75 psi.

For complete information on the advantages of power transmission by Fawick, call your nearest Fawick representative or write the Home Office.

FAWICK AIRFLEX DIVISION
FAWICK CORPORATION
9919 CLINTON ROAD • CLEVELAND 11, OHIO
Fawick Canada, Ltd., 60 Front St., West, Toronto, Ont., Canada

FAWICK AIRFLEX
INDUSTRIAL CLUTCHES AND BRAKES



NEW SIZE RANGE SURPRISE!

HERE'S A NEW PROCESS in centrifugally spun tubing that offers you greater freedom in design. It's ACIPCO CERAM-SPUN®... the new ceramic mold process* that is not limited by equipment sizes!

NOW, YOU CAN ORDER almost any combination of sizes you require. ACIPCO CERAM-SPUN® tubes offer O.D.'s from 2.25" to 50"; and wall thicknesses from .25" to 8". As-cast lengths are furnished from 4 feet to 20 feet, longer lengths are made by welding.

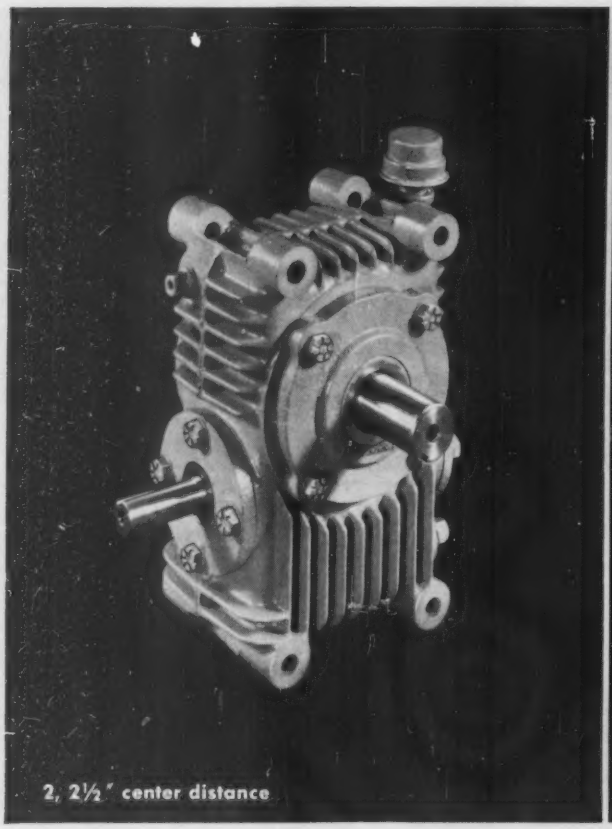
THINK OF HOW MUCH this process can save you! You'll avoid the cost of unnecessary metal waste, and excessive machining charges. And ACIPCO's complete "under one roof" operations — including heat treating, machining and welding — offer many additional economies. No need for the delays and excessive costs that often result in buying from multiple sources.

If you design, manufacture or use tubular component parts, it will certainly pay you to investigate the versatility of ACIPCO CERAM-SPUN® tubing and the flexibility of ACIPCO's integrated facilities. Contact **ACIPCO STEEL PRODUCTS,** Division of American Cast Iron Pipe Company, Birmingham 2, Alabama.

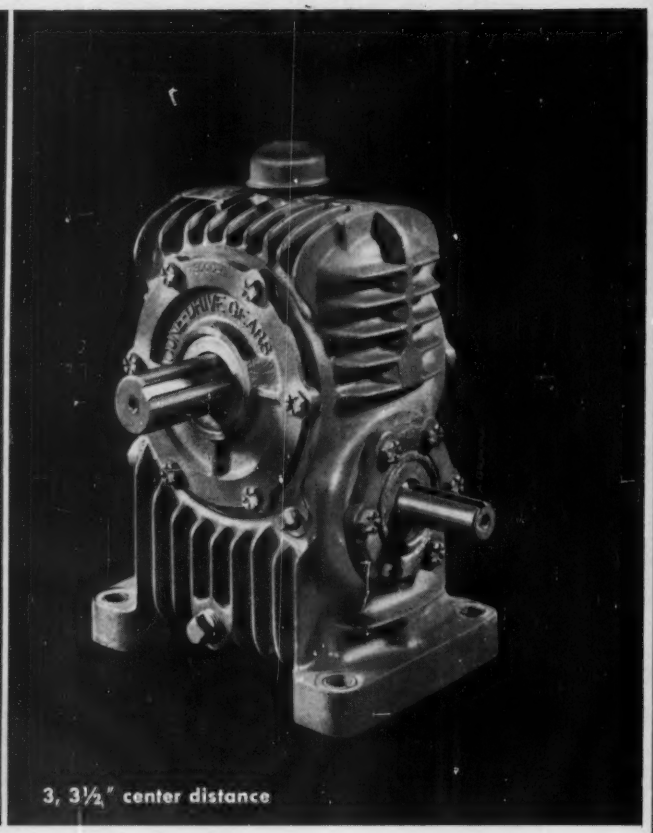
*Patent applied for

ACIPCO CERAM-SPUN®
STEEL TUBING

Circle 267 on Page 19



2, 2½″ center distance



3, 3½″ center distance

Custom-build Your Worm Gear Drive from . . .

OVER 200,000 STOCK

The four "worm-under" speed reducers shown above represent only eleven sizes of standard, Cone-Drive units. Also standard are 15″, 18″, 22″, and 24″ center distance units. Cone-Drive worm gear reducers are available in ratios from 5:1 to 4900:1 and up to over 1200 HP capacity. All units feature the double-enveloping principle in which the worm and gear wrap around each other for greatest tooth contact, strength, smoothness, shock-resistance and quietness of operation.

All Cone-Drive worm-gear reducers feature heavy, ribbed, nickel-iron castings for maximum strength and heat dissipation. Heavy-duty taper roller bearings provide anti-friction support to both worm and gear shafts. Chrome-molybdenum-nickel steel worms and tin bronze gears provide long life and high strength. The Cone-Drive design also gives the exclusive benefit that, in service, both gear and worm tend to regenerate their true form . . . worm and gear wear "in" rather than "out."

Standard Options

By selecting various options, standard units can be obtained to fit almost any drive requirements. By taking advantage of these options in the early design stages, you can often simplify design and improve performance, too. Including size and ratio ranges and options available, Cone-Drive Gears offers over 200,000 worm-gear speed reducer combinations that are standard, shelf-hardware items. Special sizes and ratios can be furnished on a quotation basis. Write for Bulletin CD-218 for complete details.

CONE-DRIVE GEARS DIVISION MICHIGAN TOOL COMPANY

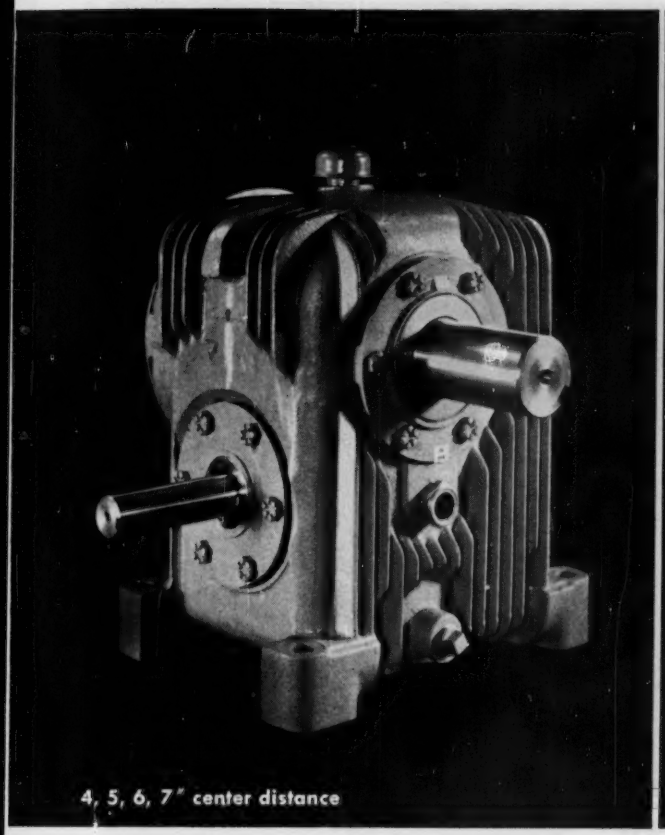
7171 E. McNichols Road • Detroit 12, Michigan • Telephone: TWinbrook 1-3111

DOUBLE-ENVELOPING WORM GEARSETS

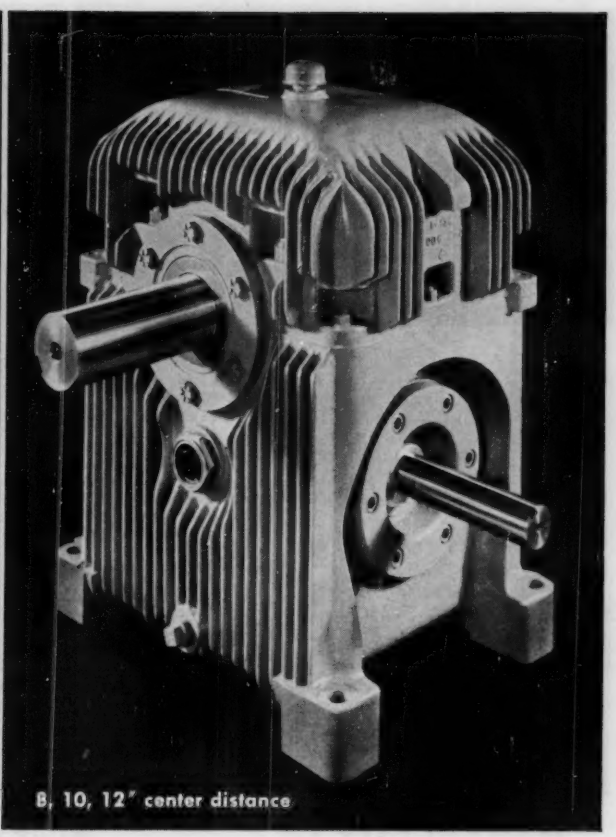
DOUBLE-ENVELOPING WORM GEAR SPEED REDUCERS

DOUBLE REDUCTION WORM GEAR SPEED REDUCERS

DOUBLE-ENVELOPING RIGHT ANGLE GEARMOTORS



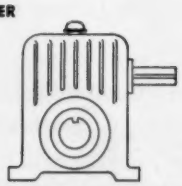
4, 5, 6, 7″ center distance



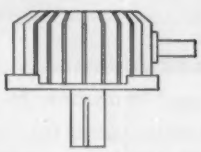
8, 10, 12″ center distance

CONE-DRIVE REDUCERS

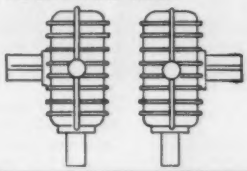
WORM-OVER



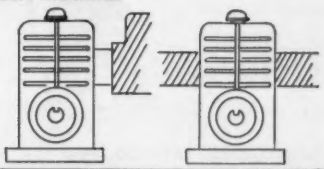
VERTICAL GEARSHAFT



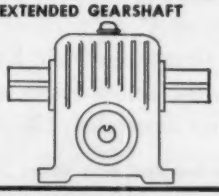
RIGHT- OR LEFT-HAND SHAFT



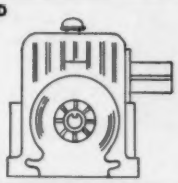
SHAFT MOUNTED



DOUBLE-EXTENDED GEARSHAFT

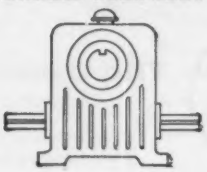


FAN-COOLED

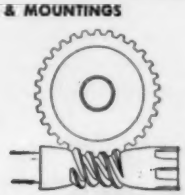


DOUBLE REDUCTION

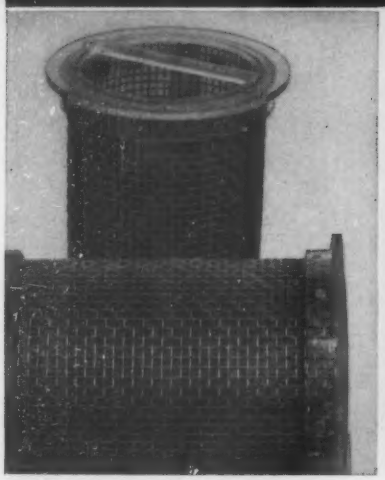
DOUBLE-EXTENDED WORM SHAFT



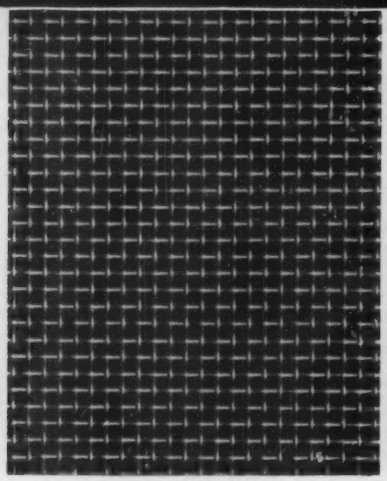
GEARSETS & MOUNTINGS



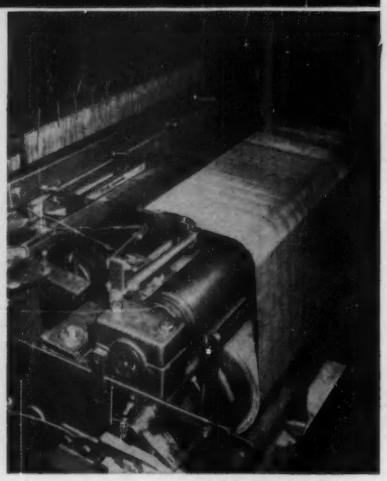
Need Wire Cloth in Special Metals? call *Cambridge*



HASTELLOY C*



SILVER



TITANIUM

Working with unusual metals or alloys—as well as with standard metals and alloys—is almost an everyday occurrence at Cambridge. For instance, not too long ago, we developed the first practical method of weaving titanium into wire cloth—with mesh counts far higher than had been expected by the customer. Platinum, lead, stainless steel, or bronze—whatever the metal or alloy used, Cambridge has the experience and facilities to produce wire cloth in any size or quantities to the closest tolerances.

If you require fabrications—of any shape or size—Cambridge has the craftsmen and know-how to fill even the most rigid specifications. Or, we'll draw up prints for your approval. There's a wire cloth expert near you—ready to discuss your needs and show you how to get what you want economically and on time. He's your Cambridge Field Engineer... and his name is listed in the Yellow Pages under "Wire Cloth." Or, write for our illustrated, 120-page catalog.

Refer to our technical data sheets in CHEMICAL ENGINEERING CATALOG, Page 185

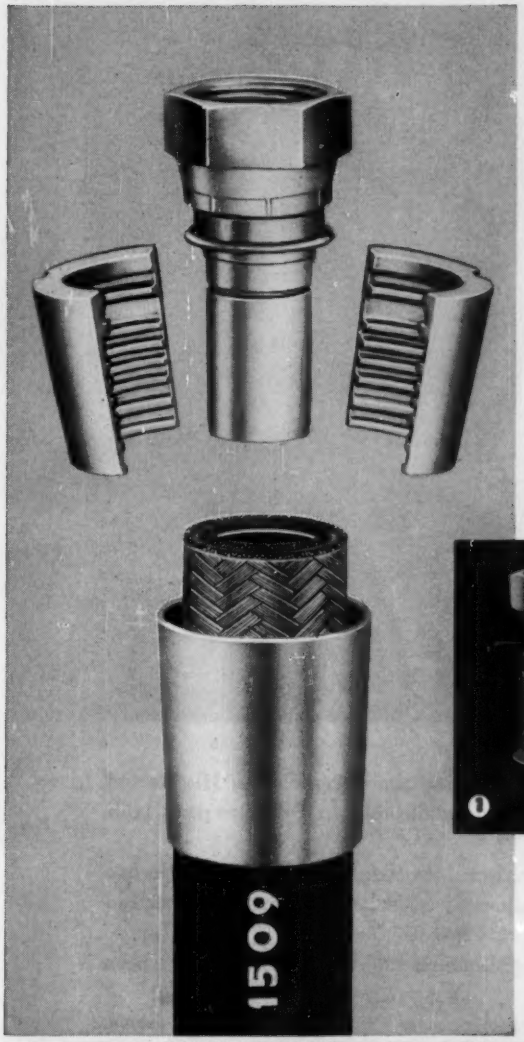
The Cambridge Wire Cloth Co.

DEPARTMENT N • CAMBRIDGE 9, MARYLAND

Manufacturers of Wire Cloth, Wire Cloth Fabrications, Metal-Mesh Conveyor Belts and Gripper® Metal-Mesh Slings.

*Reg. T.M. of Union Carbide Co.

NEW IRON MIKE T.M.

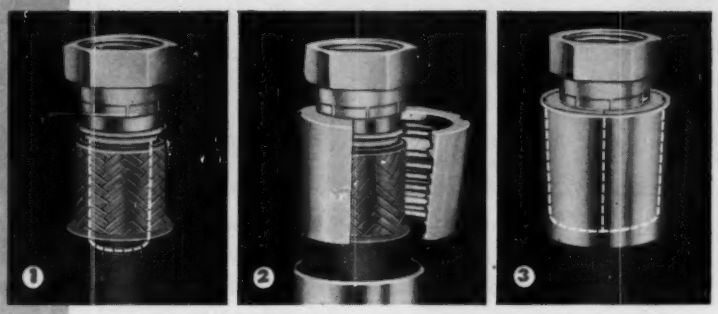


REUSABILITY PLUS LOW COST MAKE IT THE MOST IMPORTANT NEW HIGH PRESSURE HOSE FITTING IN YEARS

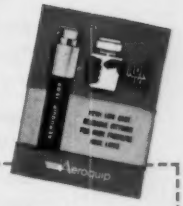
Aeroquip scores a major breakthrough in the cost of high pressure hose lines. IRON MIKE Fittings are completely reusable! IRON MIKE Fittings are exceptionally low cost! They give you the design, prototype, manufacturing and field service advantages provided by hose lines with standard reusable fittings . . . at the low cost of hose lines with non-reusable fittings.

Use IRON MIKE Fittings with Aeroquip Multiple Wire Braid Hose for hydraulic systems up to 2250 psi. as well as for pneumatic, fuel and lubrication lines. IRON MIKE Fittings are available with 10 standard end styles for hose sizes from ¼" to 2" I.D.

Field tested and thoroughly dependable, IRON MIKE Fittings feature quick, easy, foolproof assembly. Get complete information by returning the coupon below.



IRON MIKE Fittings consist of a steel nipple, two aluminum segments, and a tapered steel socket. Assembly of IRON MIKE Fittings and 1509 Hose is simple and sure: 1. Rubber Cover is stripped from hose end and threadless nipple is inserted into hose. 2. Two segments mate with nipple assembly to assure correct positioning. 3. Tapered socket is forced over segments to form a rugged compression fitting.



PATENT APPLIED FOR

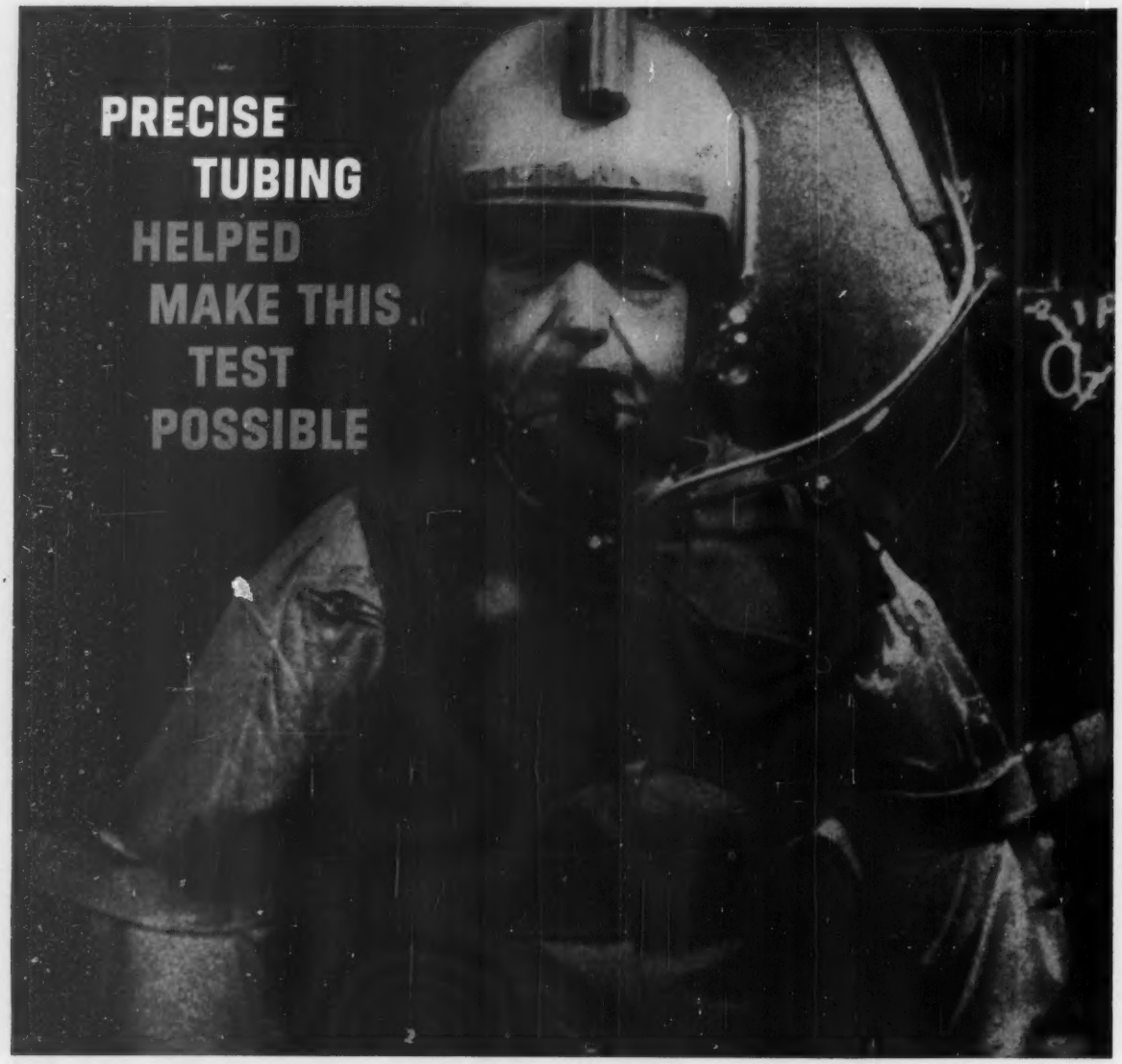
Aeroquip

REG. TRADEMARK

AEROQUIP CORPORATION • JACKSON, MICHIGAN
INDUSTRIAL DIVISION
INDUSTRIAL PLANTS: VAN WERT, OHIO; BURBANK, CALIFORNIA; DALLAS, TEXAS; PORTLAND, OREGON; PATERSON, NEW JERSEY
In Canada: Aeroquip (Canada) Ltd., Toronto 19, Ontario
In Germany: Aeroquip G.m.b.H., Baden Baden-Oos

Aeroquip Corporation, Jackson, Michigan
Please send me Bulletin 651 on new IRON MIKE Fittings. MD-9

Name_____
Title_____
Company_____
Address_____
City_____ Zone_____ State_____



That's a test pilot undergoing several "G's" in one of those human centrifuges. His life and the progress of future generations depend on the performance of many tubular parts built to rigid specifications, tight tolerances.

We make stainless steel and nickel tubing in mechanical, aircraft, capillary and hypodermic grades in sizes up to 1 inch OD—plus an amazing variety of "specialties" such as super and "exotic" alloys, glass-to-metal sealing alloys and clad metals.

In addition, we produce a vast line of platinum products and chemicals that have been used by industry for over a century.

We are unique because of our ability to *work these metals to such tiny, precise forms.* Bulletin No. 12 describes our tubular products–Catalog No. P-6 describes our platinum products. Write for them.

BISHOP

Tubular Products Division **J. BISHOP & CO.** *platinum works* MALVERN, PENNSYLVANIA

A JOHNSON MATTHEY ASSOCIATE "METALS FOR PRECISION AND PERFORMANCE"

OFFICES: NEW YORK • PITTSBURGH • CHICAGO • ATLANTA • HOUSTON • LOS ANGELES

P-e-e-l-i-n-g down to a perfect fit

Just a twist of a pen knife when your shims are made of LAMINUM® and you have a perfect fit—right on the assembly line. No machining. No grinding. No counting. No stacking. No miking. No costly stand-by equipment.

LAMINUM is the registered trade name for laminated shim stock that looks and acts like solid metal. Plastic or metallic bonded, the laminations p-e-e-l off easily to give you a perfect fit—right to a thousandth—right on the job.

Custom-made to your own blueprint specifications—in any quantity—shims of LAMINUM are produced *exactly for your job.* In brass . . . mild steel . . . stainless . . . aluminum . . . laminations of .002″ or .003″. **And now also in Titanium with laminations of .003″!** You name it! You specify it! You have it!

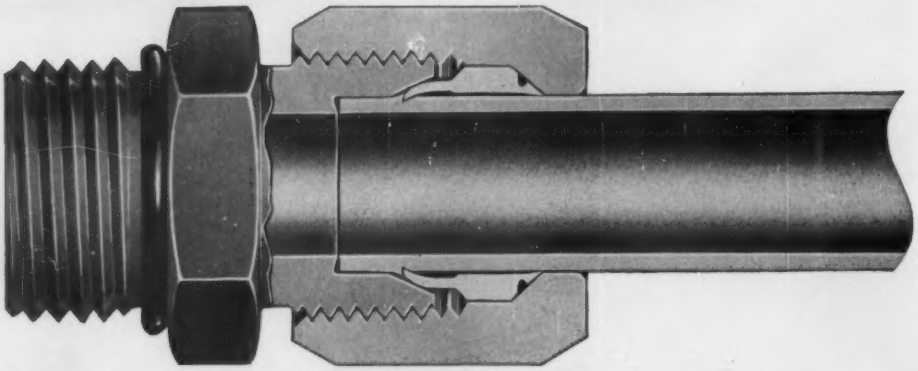
Find out how LAMINUM can save you time and money on your assemblies. Just write for revised SHIM DESIGN FOLDER No. 4 for complete, up-to-the-minute engineering data.

LAMINUM®

THE LAMINATED SHIM COMPANY, INC.
West Coast Sales and Service - 600 Sixteenth St., Oakland, Calif.
Home Office and Plant - 1209 Union St., Glenbrook, Conn.

Circle 272 on Page 19

ONLY PARKER "FERULOK®" FLARELESS FITTINGS



GIVE YOU DOUBLE SEALING ACTION

Built for heavy duty but ideal for standard tubing as well, Ferulok's visible bite means a safe, leak-proof connection which will hold well beyond tube bursting pressures. You can see this bite, inspect it . . . and *know* that you have safe make-up.

The same wedging action that seals ferrule to tube and ferrule to fitting body also results in a firm grip on the tube by the "heel" of the ferrule, damping vibration and preventing stresses from concentrating at the line of bite.

Made in steel, stainless steel and Monel, Ferulok meets, and actually exceeds, the performance standards set by S.A.E., J.I.C., and A.S.M.E. It also has Underwriters' Approval and meets federal specification MIL-F-5506 and BuShips specification MIL-F-21467 for hydraulic and air systems in Naval ships.

Get the complete story from your Parker-Hannifin distributor. You'll get engineering help and prompt deliveries as well. Check the Yellow Pages, or if you prefer, write us direct.

. . . WITH THE VISIBLE BITE

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Parker FITTINGS AND HOSE DIVISION
17325 Euclid Avenue • Cleveland 12, Ohio
PNEUMATIC AND HYDRAULIC SYSTEM COMPONENTS

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Think Quality...

THE CONSISTENT QUALITY OF HOLO-KROME THERMO-FORGED SOCKET SCREWS CUTS REJECT AND IN-WARRANTY SERVICE COSTS*

Are inspection, in-warranty and replacement costs putting a tight squeeze on your profits? Join other profit-conscious industrial leaders in turning to *quality* to reduce these costs and increase profits. THERMO-FORGED socket screws are produced by a patented electronic forging process which pre-conditions the metal. This makes possible exact control of metal flow, and allows us to maintain tolerances impossible with other forging methods. Thread rolling and subsequent operations are controlled more precisely than ever. As a result, THERMO-FORGED socket screws are unmatched in quality, free from flaws, checks and hidden imperfections, with dimensional precision unattainable with ordinary forging methods. THERMO-FORGED socket screws can materially increase your profits by reducing rejects and in-warranty service costs. See your authorized Holo-Krome distributor or write for more information.

**Trade Mark of The Holo-Krome Screw Corporation*

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SOCKET SCREWS

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Circle 274 on Page 19

GN

Pedrick

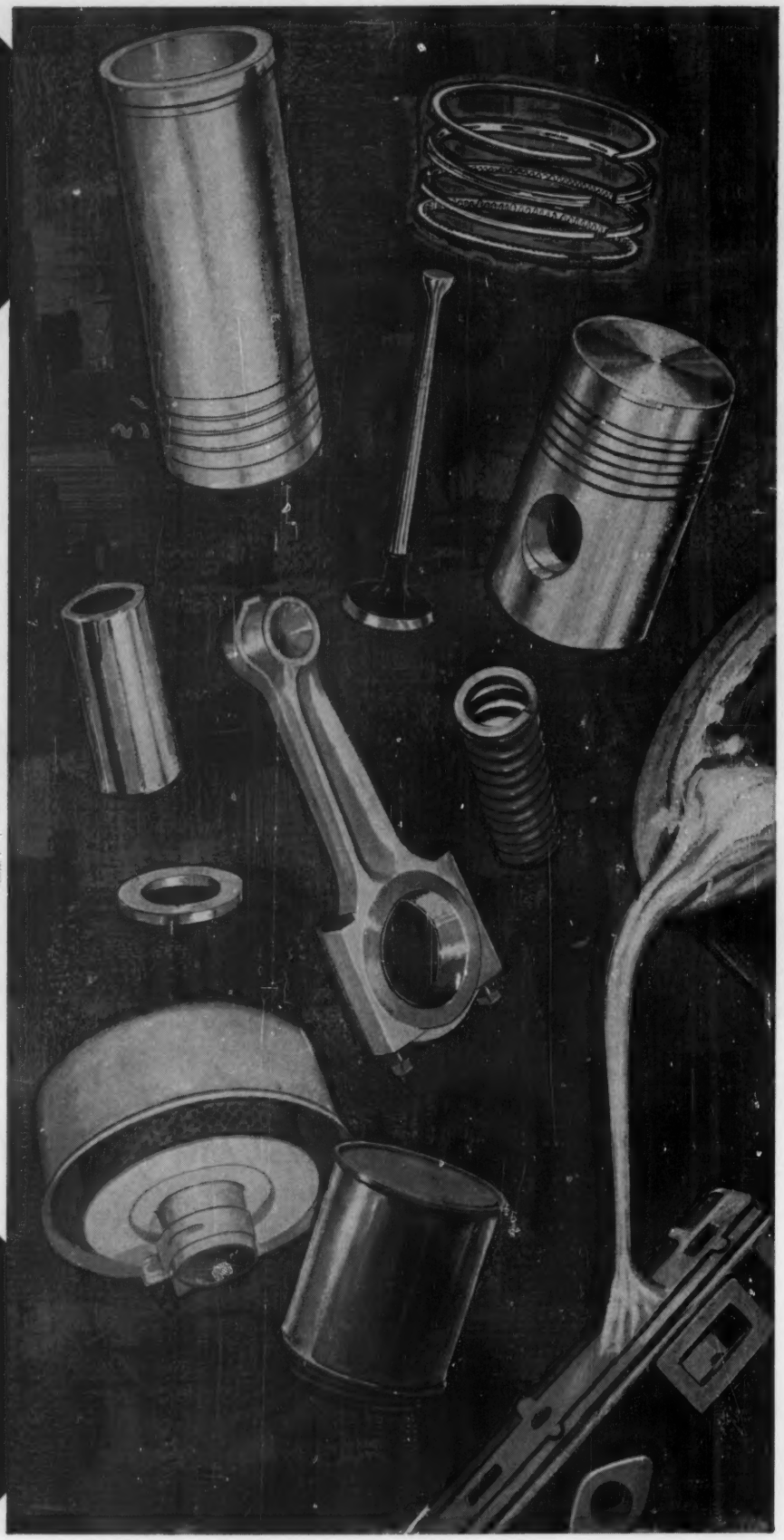
SUPERIOR

WHITE
MACHINE WORKS

BURD
GRAF-FLOX

G&E

GN



Nation's largest manufacturer of heavy-duty and specialized engine parts—

NEW GOULD-NATIONAL ENGINE PARTS DIVISION

In creating its new Engine Parts Division, Gould-National combined under one corporate roof the brands, products, services and facilities of these wholly-owned subsidiaries:

Wilkening Manufacturing Co., Philadelphia, manufacturers of Pedrick® piston rings and castings.

White Machine Works, Eau Claire, Wisconsin, manufacturers of Superior-Arrowhead cylinder sleeves, sleeve assemblies, pistons, piston pins, Burd piston rings, valves and valve train parts, foreign car engine parts and filters.

Gillett & Eaton, Lake City, Minnesota, piston and casting specialists of cast iron, aluminum alloy, Vanasil® aluminum alloy pistons and specialized engine parts.

Arrow Head Steel Products, Howell, Michigan, manufacturers of aluminum pistons, connecting rods and other castings.

Now, Gould-National, the nation's largest producer of automotive replacement batteries, is also the nation's largest basic manufacturer of heavy-duty and specialized engine parts. The Division is the largest one stop source for the most complete line of engine parts available from one manufacturer. It is the only engine parts manufacturer with both iron and aluminum casting and machining facilities.

By utilizing the efforts of one combined sales force, the customer will benefit from greater sales-service efficiency, more concentrated field coverage.

Product improvement will result from the formation of a special team in the Gould-National Engineering and Research staff. It is the Gould-National way of assuring continuing top quality and improved product performance.

New engineering developments, manufacturing and production techniques from all areas within the Division will benefit all customers, no matter what the product may be.

This is the Gould-National Engine Parts Division—the nation's newest parts manufacturing group with over two centuries of combined experience.

Need heavy-duty engine parts? Automotive engine parts? Foreign car engine parts? Parts for such specialized applications as air and refrigeration compressors? Need complete and modern facilities for aluminum and iron castings? If your specifications call for the best of these, if you need them fast and need them right . . . turn to . . .

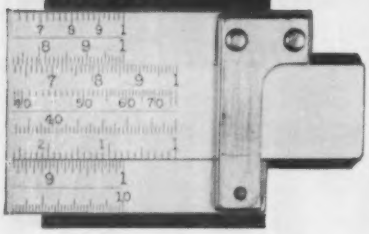
Superior-Arrowhead and Burd are trademarks of Gould-National Batteries, Inc.

GN

ENGINE PARTS DIVISION
GOULD-NATIONAL BATTERIES, INC.
St. Paul 1, Minnesota

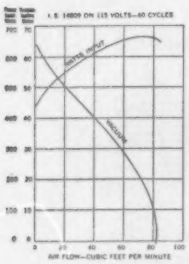
Circle 275 on Page 19

Fractional Horsepower Motors



Lamb® Helps You Select The Right Vacuum Cleaner Motor

9/16 HP, 5-11/16" fan case diameter



IS-14750 thru ventilated

APPLICATION: Domestic portable cleaners.

IS-14809 by-pass ventilated

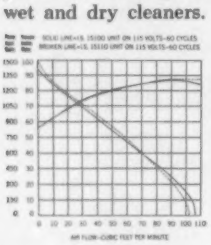
APPLICATION: Wet pick-up portable cleaners and central cleaning systems.

Service Life: Moderate
Cost: Low
Bulletins 101 & 201

NEW

1 HP, 7-3/16" fan case diameter

APPLICATION: Central vacuum systems in particular, also portable commercial wet and dry cleaners.



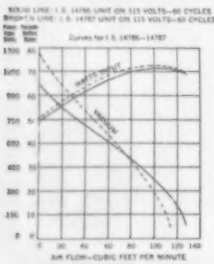
IS-15100 Diffused air discharge

IS-15110 Single air discharge

Service Life: Moderate
Cost: About twice cost of 9/16 HP
Bulletins 251 & 252

7/8 HP, 7-1/2" fan case diameter

APPLICATION: Portable Heavy Duty Commercial Cleaners and Central Systems (three-stage).



IS-14786 2-Stage

IS-14787 3-Stage

Service Life: Long
Cost: About 3 times cost of 9/16 HP
Bulletin 301

IS-15100 (Diffuser Discharge)

IS-15110 (Single Air Discharge)

Special Requirements of Central Vacuum Systems Met by New High Performance Motor

Existing vacuum motors have been designed to perform best when incorporated into portable vacuum cleaners of standard types and sizes. Such motors are built to produce highest efficiency under air flow conditions that exist in normal domestic and industrial cleaning service and where hoses are of normal length and diameter.

On special applications, like central vacuum cleaning systems that utilize extremely long cleaning hoses, and where tubing losses are present, a special motor is required. To meet this need, Lamb now offers a vacuum motor which will maintain a relatively high vacuum with a modest amount of air flow. The result: these motors operate at high efficiency in the high vacuum range without sacrificing air flow performance under low vacuum conditions.

INPUT – 10 AMPERES at 115 VOLTS

For economical, cleaner design, this rating at Underwriters' test point was selected as the input limit. This allows use of line cord not exceeding number 16 type SJ and control switches of 10 ampere rating.

NEW TAPERED BLADE DESIGN

On central systems which employ centrifugal dirt separation, a small amount of fine dirt and lint must pass through the fan and is discharged outside of the building. For maximum efficiency, this type of fan blade is designed with a long backward curving sweep which, however, may accumulate fine dirt due to centrifugal action. This dirt builds up to a point where starting acceleration dislodges dirt from one blade, resulting in unbalance, noise, and vibration. Special steep angle blades have been used but they also have serious performance limitations.

Lamb research has developed a moderately steep blade angle plus a tapered form. The result is a compromise that yields excellent performance and all but eliminates the dirt loading problem.

CHOICE OF AIR DISCHARGE SYSTEMS

Lint accumulation is minimized and high vacuum is improved in the IS-15110 with a single tangential discharge pipe. This allows for easy connection to a discharge piping system, if desired.

The IS-15100, by discharging air through slots in the fan case, results in better noise suppression.

FAN-END BEARING IS PROTECTED BY AIR COOLING

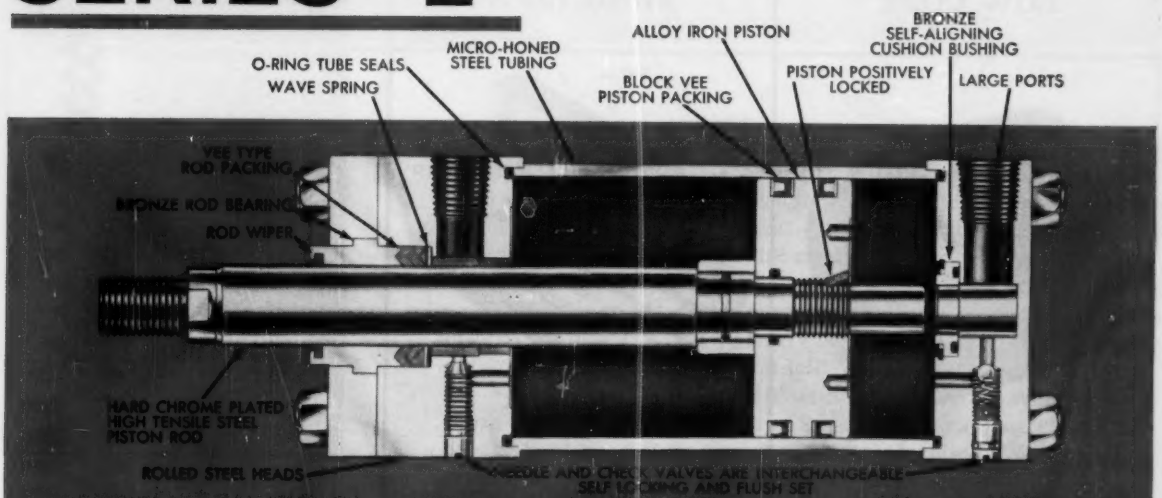
Motors in central vacuum systems are often required to operate for long periods of time under sealed conditions – which results in a high temperature rise in the fan system. In ordinary by-pass type motors, the electrical parts have a separate cooling system, but bearings in the adjacent fan case often become hot enough to destroy the lubricant. Early failures can and do result. Lamb's new motor prevents this by providing a unique ventilating system which directs cooling air over the fan-end bearing and protects the motor from harmful heat built-up within the fan case. For complete details, write to Lamb Electric Company, Kent, Ohio – ask for bulletins shown at left. *Also available – explosion-proof model. Ask for bulletin 401.*

Circle 276 on Page 19

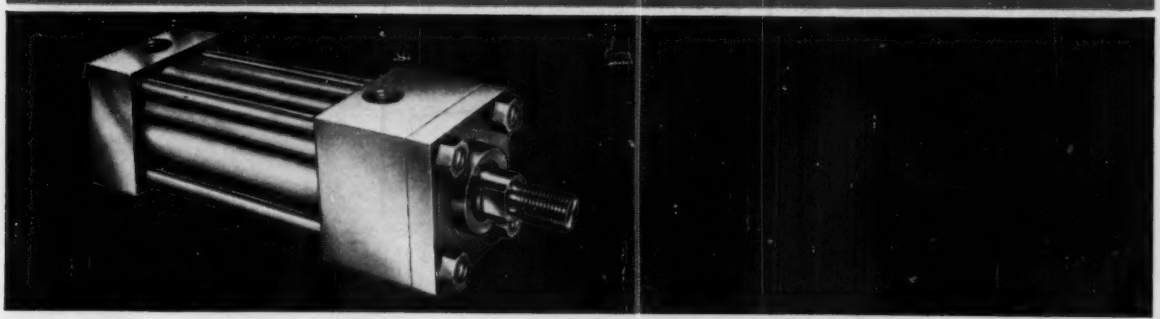
NEW O-M SQUARE HEAD HYDRAULIC CYLINDER

now available

SERIES "L"



Meets JIC Standards • Rated up to 2000 psi • 1½" to 14" Bores



For years, you have looked to Ortman-Miller for the original space-saving, tie-rodless air and hydraulic cylinders. Now, with the introduction of the new Series "K" air cylinder, recently announced, and the new Series "L", hydraulic cylinder, featured above, you can look to O-M for all of your cylinder requirements.

A product of the teamwork of O-M specialists, this new Series "L" hydraulic unit reflects the research, design, engineering and production capabilities and experience that are an integral part of every O-M cylinder. The result, a quality, hydraulic cylinder designed for long service, high operational efficiency and quick, easy maintenance, dimensionally interchangeable with most cylinders of a like type.

For complete details mail coupon today for Bulletin No. 116 in which all cylinders have been dimensioned in accordance with NFPA recommendations for your convenience.

ORTMAN-MILLER MACHINE COMPANY
7 143rd Street, Hammond, Indiana

☐ Have representative call

Send Bulletins

☐ 115 ☐ 116 Series "L"

NAME_____ POSITION_____

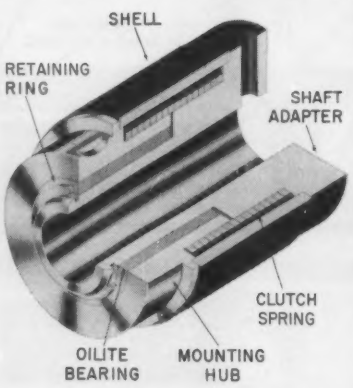
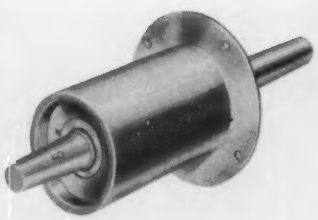
COMPANY_____

ADDRESS_____

CITY_____ ZONE____ STATE_____

Circle 277 on Page 19

Precisionspring CLUTCHES

LOW COST	LONG LIFE	SMALL SIZE
		
The basic cost of Curtiss-Wright clutches is lower than others of comparable size. They require only a small energizing force, so inexpensive actuation may be used. The clutch costs less — it may reduce the cost of other mechanism parts too.	Standard Curtiss-Wright clutches are available in torque capacities from 8 to 1250 lb./in. Other units custom designed to specification, for practically any braking or clutching problem. Transmitted torque is constant throughout life of the clutch.	Curtiss-Wright clutches are smaller than any other clutch of comparable torque rating. Per unit of transmitted torque they are lighter and more compact. Instantaneous, positive gripping action eliminates slippage, wear and lost cycling time.
EASY ACTUATION	**FLEXIBLE DESIGN**	**POSITIVE ACTION**

Industry's Most Diversified Line of Spring Clutches

MARQUETTE DIVISION
CURTISS-WRIGHT
CORPORATION

1145 GALEWOOD DRIVE
CLEVELAND 10, OHIO

Distributed in Canada by
Canadian Curtiss-Wright Ltd.
Toronto & Montreal, Canada

AD NO. 32-30

Curtiss-Wright clutches have proved their long life and dependable service in many diversified applications in a variety of industries. Compactly designed for instantaneous, positive action at very high speed without loss in efficiency. No slippage . . . no wear — low maintenance. Excellent for installation in inaccessible spots — need no lubrication and operate equally well in either an oil bath or dry.

A skilled staff of Curtiss-Wright engineers will help you pick the proper clutch for your application — or custom design a special clutch for the job. Write today for a complete catalog, or for consultation with a Marquette Division application engineer.

Circle 278 on Page 19

Circle 279 on Page 19→

Keystone Wire solves dairy brush forming and corrosion problems

Uniform wire softness is needed to perform brush twisting operations on high-speed twisting machines. To solve this problem, Keystone Steel & Wire Company developed for Regal Manufacturing Company, Fond du Lac, Wisc., a dead soft galvanized twisted Brush Handle Quality Wire. A special tight zinc coating is designed to adhere firmly during the severe twisting.

Regal Manufacturing Company specializes in making unusual brushes for the dairy and creamery industry—for example, the milking machine brush illustrated at left.

For filled brushes, galvanized stapling wire anchors crimped white nylon bristles into brush blocks of Super Hi-Impact plastic, hard rubber and hard wood. Regal uses Keystone's galvanized Stapling Quality Wire to resist corrosion from water and lactic acid.

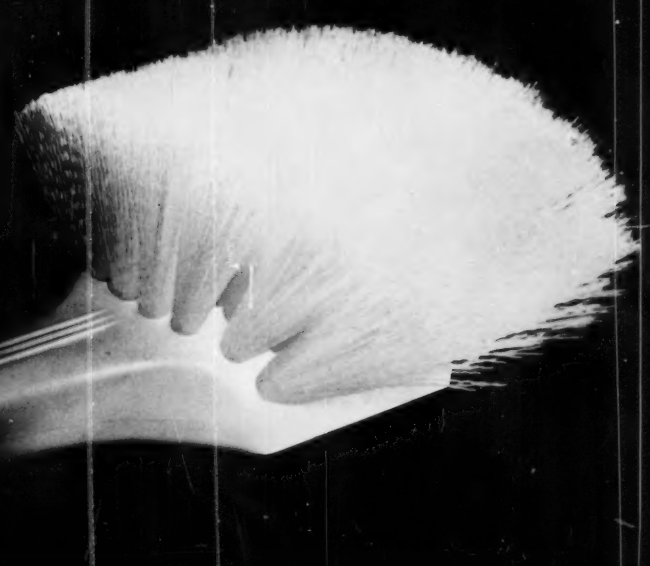
These quality wires are products of Keystone's Metallurgical Laboratories. If you make brushes or other wire formed products and want to improve them, tell us about your wire needs. We shall analyze your requirements and make the necessary recommendations.

Keystone Steel & Wire Company, Peoria, Illinois

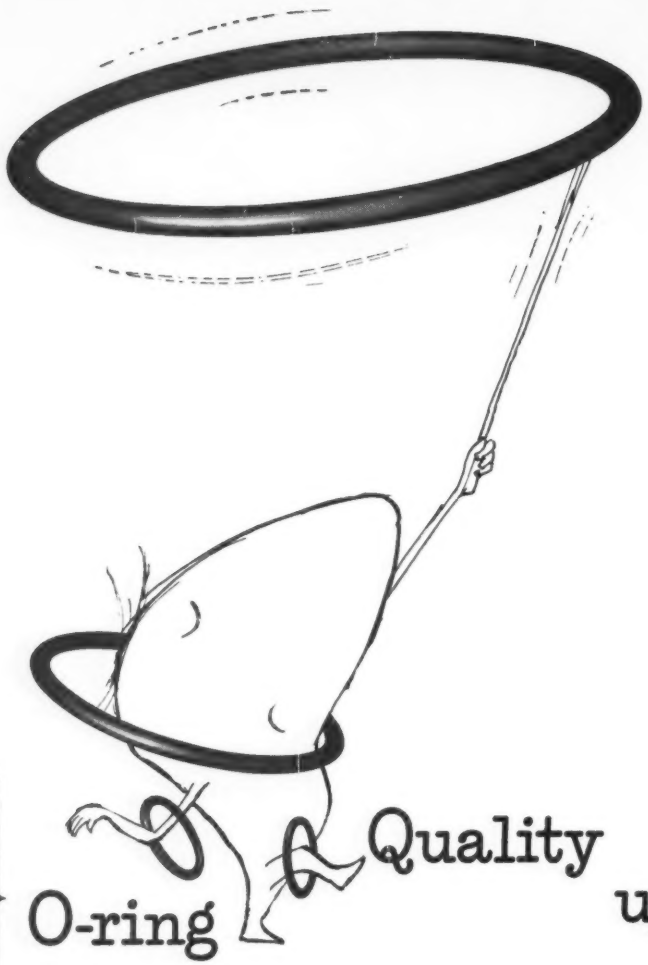
KEYSTONE

WIRE FOR INDUSTRY

MADE AT PEORIA, ILLINOIS, U.S.A.



REGAL BRUSHES



Are you keeping your O-ring Quality up?

"For want of a nail..." The same burden may often fall on the tiny O-Ring. In overall product reliability the smallest parts are vital to performance. That's why IPC uses the famed "custom" approach in designing and manufacturing O-Rings.

Analyzing your application in terms of extensive compounding experience . . . IPC then customize tooling and manufacture under the most exacting quality control standards in the O-Ring industry.

Next time, in fact *anytime*, you suspect O-Rings are a critical factor in product performance, ask your IPC sales engineer to lend a hand. He has some interesting data which can help you evaluate O-Ring performance!

IPC

OIL SEALS
PACKINGS
PRECISION MOLDING *Custom designed for your application*

INTERNATIONAL PACKINGS CORPORATION

Bristol, New Hampshire

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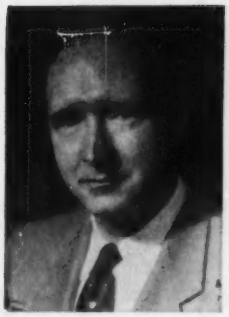
P4

Circle 280 on Page 19

MACHINE DESIGN
September 28, 1961



Who Needs Whom?

BUSINESS transactions involving goods or services supposedly are to the mutual benefit of buyer and seller. You have something I need, and you need something I have, so let's get together and trade.

Yet for some obscure reason the one who has the money automatically assumes the upper hand. And the one who has the goods or services to offer meekly accepts the role of suppliant.

Why this assumption that the seller needs the money more than the buyer needs the goods or services? Yet "the customer is always right" and "the salesman buys the drinks" are well-nigh universal business axioms. Only in a completely abnormal situation — such as the automobile market right after the last war—is the situation reversed.

Like many others in business, the buyer of materials, components, and engineering services, which become incorporated into equipment which he in turn sells to others, is in a dual position. When he gets tired of fawning over his customers and prospects, he can take it out on his suppliers and contractors, actual or prospective, by lording it over them.

But the quality of the product which he sells is totally dependent on the quality of components—and engineering—which he may have bought. Therefore, he cannot afford to indulge such childish fancies. His buying decisions and his dealings with his contractors must be strictly objective. He may need the services more than the contractor needs the money.

Guideposts to intelligent buying of research, development, and engineering services are spelled out in Bob Murdick's article overleaf. Notice that the personality of the contractor's representative, and the lavishness of his spending on entertainment, are not listed among the criteria for selection.

Colin Carmichael

EDITOR

How to **Evaluate**

- Technical aspects
- Relative costs
- Time schedules
- Technical competence
- Management competence
- Financial responsibility
- "Eagerness"

MUCH has been written on how to sell technical services and equipment. Selling has become almost a science. However, when it comes to spending money, the art has been sadly neglected. Yet this is the most important side of the transaction, since no company can afford the losses involved in paying too high a price or obtaining an inferior product or service.

The methods for obtaining and evaluating bids for research engineering and engineered equipment (as opposed to stock items) are described in this article. Most of the emphasis is on contracts awarded on the basis of competitive bids. Negotiated contracts are usually entered into because many of the factors which must be considered in competitive awards need not be considered.

Engineers often refer to any company which furnishes any kind of equipment as a "vendor." This is true even though the company actually furnishes (from a cost viewpoint) considerable development and advanced engineering compared with the equipment it eventually produces. From the purchasing viewpoint, a contract rather than (or in addition to) a purchase order is usually required to obtain such complex services, and the purchasing agent may refer to such suppliers as "contractors."

Obtaining the Bids

The first step in buying is to determine as nearly as possible what it is you want to buy. The formu-

Circle 20-2 on Page 19 for extra copy.

Engineering Proposals

ROBERT G. MURDICK
Dept. of Management Engineering
Rensselaer Polytechnic Institute
Troy, N. Y.

lation of this want in the technical area is a description of R & D desired or specification of equipment to be designed and possibly delivered. Other information relating to the engineering requirements is given in Table 1.

The purchasing organization next obtains bids by one of three methods:

1. Advertises for bidders.
2. Sends out invitations to bid to all known firms who could possibly supply the engineering and/or research service.
3. Sends out requests-to-quote to a selected list of companies believed to be competent in the field. Some agencies of the Armed Forces keep up-to-date lists of "certified" bidders for various categories of services.

If advertising is used, it should be placed in newspapers, trade journals, or other publications to insure that it reaches interested, competent bidders. An advertisement usually carries only enough information to enable a prospective bidder to determine if he has a possible interest. The advertisement should clearly state where, when, by whom, and for what proposals are to be received. Since potential bidders usually send technical representatives and may spend significant sums of money in engineering evaluation and proposal preparation,

If a seller doesn't make a sale, he hasn't lost anything; he simply hasn't gained. But if a buyer makes a poor decision he might lose a considerable sum of money. A careful step-by-step analysis of proposals is mandatory when buying engineering and research services, or specialized equipment. Presented here are the factors to be considered and pitfalls to be avoided.

advertisements should not be placed until authorization has been obtained for funds to complete the purchase. A checklist of points to be included in the advertisement are given in Table 2. Sufficient time (ordinarily three weeks minimum) should be allowed from the time of advertising or mailing of request-to-bid letters to allow the bidders time to meet with the responsible technical and purchasing people.

The first rough evaluation of bidders begins with the prebid conferences (if the "certified" list approach is not used). The quality and level of technical representatives the company sends are tipoffs of their interest and competence. Ability of representatives to grasp tough or unforeseen technical problems gives valuable insight into the company. These prebidding conferences often determine how badly the would-be bidder wants the job. This is important because it gives an idea of the priority, type of personnel and effort, and general service which will be provided. A small company which is anxious to get its foot in the door will be more eager to go all out, perhaps, than a large company for which the contract is only a drop in the bucket.

Table 1—Information To Be Furnished to Bidders

1. Description of the required material or service should include the name and exact services (i.e., research, develop, design, fabricate, test, etc.).
2. Quantities should include a separate listing of all test and evaluation models, and spare parts.
3. All applicable technical specifications (if, for example, MIL specs are used as a basis) should be given and listed by name or number.
4. All applicable drawing references should be listed.
5. The number of copies of vendor drawings required should be given.
6. Type and number of copies of instruction books and training manuals (if any) should be given.
7. Inspection requirements should be given.
8. Identification, packaging and shipping instructions should be specified.
9. Cost breakdown may be specified.
10. Security classification of the work may be required.
11. Liaison instructions should be given.
12. List of equipment or material which may be supplied to the vendor should be described.
13. End date by which work is to be completed (and, if equipment, shipped) should be given.

Evaluating the Proposals

"Evaluating the proposals" has a much broader meaning than simply comparing costs for various bids submitted. To evaluate the technical proposal the following must be considered:

1. Technical aspects of the proposal.
2. Relative costs.
3. Proposed time schedules.
4. Technical competence of the firms.
5. Management competence of the firms.
6. Financial responsibility of the firms.
7. Eagerness of the firms to take on the job.

Technical Aspects: Evaluating the technical aspects involves a number of points. Does the proposal show that the firm understood the problem? Were alternate solutions offered? Was the technical analysis as shown by the proposal mature? Are advanced but realistic concepts offered? Did the bidder take exception to any specifications? Which ones and why? Did he provide substitute specifications when he took exception?

Reliability standards which vendors claim should be compared carefully. In most equipment today, greater emphasis is being placed on reliability of components and systems because reliability is now measured in quantitative terms. Suppliers who claim that prospective equipment has "high reliability" are really saying nothing. Reliability is measured by stating how long each part or system will function under some specified condition. Reliability of components determines the probability of system failure under specified operating conditions.

Quality control is, of course, important to the buyer. Vendors may be urged to present information on the quality-control organization and operations including:

1. Machine operators. Often operators, such as welders, must be checked out on a rigid test and certified.
2. Checking procedure. At what stages are inspection checks made, in what sequence are they made, and how much checking will be made and controlled?
3. Performance of checkers. What past records are shown on accuracy with which checker and inspector are performing?
4. Testing equipment. What kinds of testing equipment does the vendor have and how well is it maintained?
5. Percentage of defects in the product. If a production order follows the engineering work, what maximum percentage of defects in product shipped is specified?

Not often can the buyer obtain such detailed and unbiased information from bidders. To a great extent the supplier's written guaranty of quality must be relied on. In principle, the guaranty puts the purchaser in the position he would have been in if the product had been good in the first place. There are two kinds of warranties—express and implied. Although they are rarely invoked, the pur-

Table 2—Outline of Advertisement for Bidders

1. By whom bids will be received.
2. Where received.
3. When received.
4. Nature of work or material to be furnished.
5. Location of work.
6. Amount of work or material to be furnished.
7. When contract is to be begun and when finished.
8. Where plans may be seen or obtained.
9. Where specifications may be seen or obtained.
10. What security will be required with proposal.
11. What bond will be required with contract.
12. When proposals will be opened.
13. When contract will be awarded.
14. From whom general information may be obtained.
15. Reservation of rights to reject any or all bids, or to waive informalities.
16. Official signatures of officers letting work or receiving bids.

chaser should obtain legal counsel regarding warranties which are implied rather than expressly stated.

The four types of express warranties of most interest to purchasers of engineered equipment are: 1. Compliance with some fixed standard. 2. Performance warranty. 3. Mechanical perfection ("We warrant every new widget to be free from defects in material and workmanship under normal use and service . . ."). 4. Freedom from harmful or disadvantageous results in use.

As a guaranty of performance of contract, particularly when the ratio of service (engineering development) to equipment is high, the buyer may require the contractor to furnish a guaranty bond. A typical statement included in the contract might be:

"The Owner shall have the right, prior to the signing of the Contract, to require the Contractor to furnish bond covering the faithful performance of the Contract and the payment of all obligations arising thereunder, in such form as the Owner may prescribe and with such sureties as he may approve. If such bond is required by instructions given previous to the submission of bids, the premium shall be paid by the Contractor; if subsequent thereto, it shall be paid by the Owner."

Relative Costs: In the invitation to bid, the purchaser may specify how the costs should be computed. Various methods are in common use. A few, whose names indicate their nature are:

1. Lump-sum or fixed price.
2. Unit price.
3. Cost plus percentage of cost.
4. Cost plus fixed fee.
5. Cost plus fixed fee plus profit-sharing arrangement.
6. Cost plus fixed fee plus bonus.
7. Cost plus a sliding scale of fees.
8. Cost-plus contract with guaranteed ceiling price.

If, for some reason, the cost basis for bidding was not specified in the request to quote, it may be difficult to compare costs accurately. Some may bid on a fixed-fee basis, some on a cost-plus-fixed-fee, or some on a time and materials or equipment cost basis, depending to a great extent on the amount of research and development work as well as the size of any subsequent production orders involved. It is obviously desirable to have all bidders bid on the same cost basis.

If the work is of a highly developmental nature and high risk, then cost plus fixed fee would normally be specified. At the other extreme, if the service simply requires some routine testing or, perhaps, the straightforward use of special facilities which the buyer doesn't have, then fixed-fee bids would be solicited. There are some in-between cases where the buyer would like to obtain fixed-fee bids, but may be afraid he will get no response at all because there is some development work required which is risky to estimate. In such a case fixed-fee bids might be requested but not required. The combinations of technical services and costs which bidders might come up with require considerable skill to evaluate.

It is well to have a team of accountants and engineers working together to evaluate costs. Variations in quality (or quantity if not specified) of such items as instruction books, spare parts, and repair tools, all represent differences in total cost. Overhead rates may vary from 50 to 150 per cent. This is because many companies try to charge as many expenses as possible to direct accounts. But total costs are not affected by different accounting methods.

Time Schedules: The form in which schedules are presented is an indication of the technical experience of the company. If R & D is scheduled in very fine detail there is cause to suspect the company's experience. On the other hand, if only a few key dates are thrown in for engineering development, the same is true. With R & D, target dates for the principal milestones should be spelled out. For engineering work, and equipment design and production, a fairly detailed, consistent, and reasonable schedule for the work should be given from beginning to end.

Technical Competence: Technical competence of

the bidders may be judged by information from such sources as:

1. Known reputation in the field.
2. Experience of previous clients of the bidders.
3. General quality of the proposal, particularly the technical sections.
4. Reputations and stated backgrounds of key technical personnel described in the proposals, including technical supporting personnel and research staff.
5. Technical facilities and equipment of the firms.
6. Length of time the firms have been engaged in technical work of the nature and scope on which they are bidding.

For convenience, research, engineering, and production facilities may be considered under technical competence of the firm. Characteristics with regard to facilities which may be evaluated are:

1. Number, size, location, type, layout, condition, and modernness of laboratories, offices and production areas.
2. Types, kinds, condition, and modernness of laboratory and production equipment.
3. Relevant excess capacities.

Management Competence of the Firm: The competence of the management of the firm may be judged from the following information determined from the proposals or outside sources:

1. The general reputation of the firm in the industry.
2. Profit position and growth of the firm.
3. Age, experience, special talents, and length of service of its management.
4. Depth or "backup" of management talent.
5. Extent of decentralization of individual responsibility.

Financial Responsibility: Sources of financial information are Dun and Bradstreet, retail credit associations (for individuals) and suppliers, banks, annual reports and SEC information, if the firm is listed on an exchange. Items to be considered are:

1. Capital structure.
2. Liquidity.
3. Retained income, credit and availability of capital.
4. Flexibility of fiscal policies.

Lack of sufficient working capital as well as doubtful over-all financial responsibility are grounds for disqualification.

"Eagerness": While the desire of a bidder to take on a job may be a subjective quantity, it is an important one. If the job is small relative to the size of a firm, it will probably be treated with care but only as one of many and of less priority than the big projects the firm has in progress. This means that personalized consideration and service normally given by a smaller firm with a low backlog cannot be expected. When a project receives high priority in a firm, liaison is much better, and minor crises can be handled more co-operatively and expeditiously.

The eagerness of a bidder may be judged from the level of technical and managerial personnel sent to the preliminary discussions, the liaison and questioning during the prebidding period, and the level of technical and managerial personnel assigned to the project. If it is possible to estimate the backlog of the firm, this gives a further clue.

Table 3—Rating of a Proposal

Factor	Company X	Max No. of Points	Rating
1	Technical aspects	500	450
2	Cost	400	300
3	Time schedule	300	300
4	Technical competence	400	375
5	Management competence	300	225
6	Financial responsibility	400	375
7	Interest in the job	200	200
	TOTAL	2500	2225

Selecting the Winning Proposal: There are a number of ways in which the final selection may be made:

1. By cost basis alone. This would be appropriate if: 1. Specifications are tight. 2. Little engineering is involved. 3. Only certified bidders are considered.
2. By management committee.
3. By the head of the firm on the basis of a staff study and recommendation.

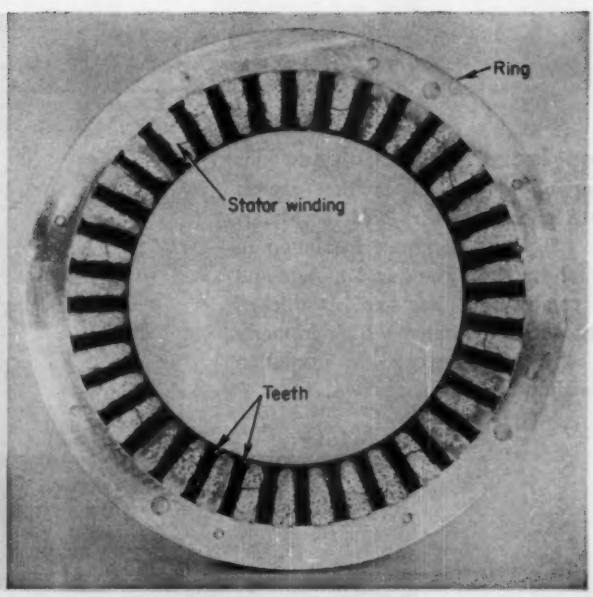
Evaluation and judgment of a technical proposal for research or complex engineered equipment involve weighing many factors and therefore must be subjective to some extent. Regardless of numerical methods used as aids, the judgment factor still enters into the decision. Numerical methods depend to a great extent on making a large number of piecemeal judgments, Table 3. Each factor is allowed a maximum number of points. Each proposal (and firm) is rated with respect to each factor. (In practice, each factor would be broken down in detail.) The final decision is then based to some extent on the firms having the maximum number of points. While this method may not be used to select *the* proposal, it may serve to eliminate some in clear-cut fashion. One high-ranking Army research director stated that technical considerations should be placed above costs as long as costs fit within the budget.

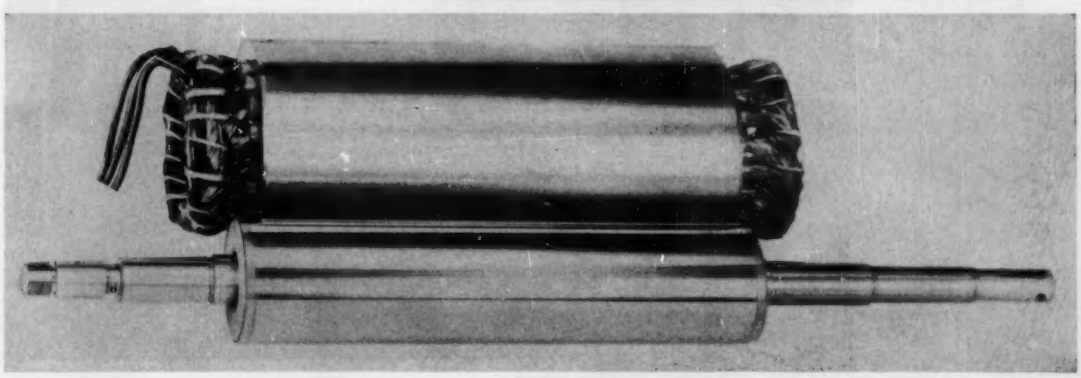
Negotiated Contracts

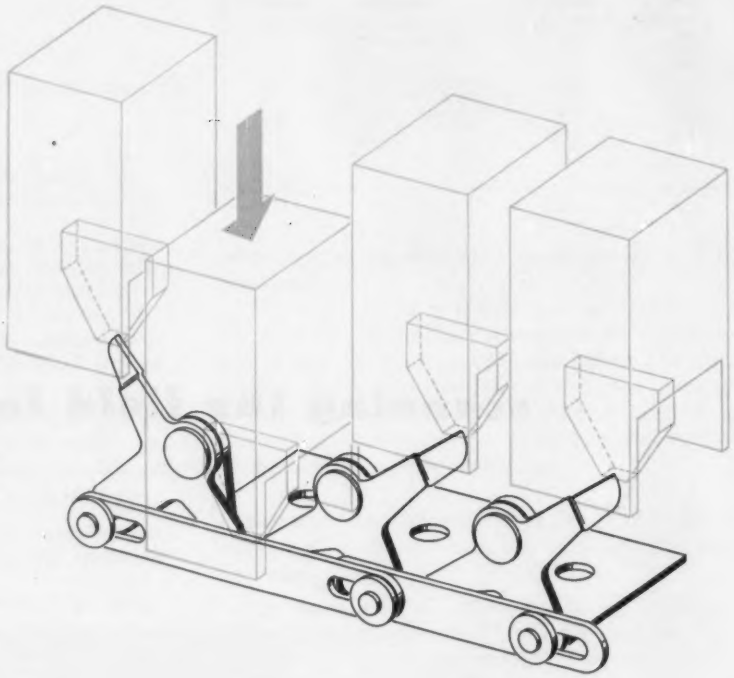
In contrast to competitive bid contracts in which the award is the result of open competition of anyone interested, negotiated contracts are awarded to selected contractors based on either past performance for the purchaser or a study of the qualifications of one or more candidates. Just because a contract is negotiated does not mean that any particular pricing arrangement must be followed. Negotiated contracts may be cost-plus-fixed-fee, fixed-price, etc.

scanning the field for *ideas*

Inside-out teeth of stator laminations permit winding of a motor stator from the outside. The stator is completed by shrink fitting a laminated ring over the wound assembly. Principle employed in motor stator by EMD Components Inc., Cleveland, Ohio.

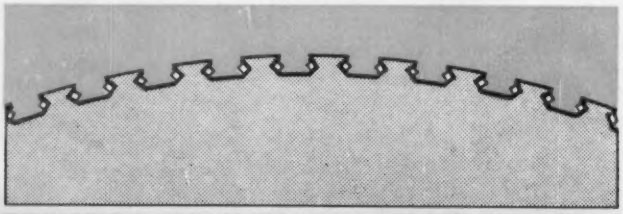


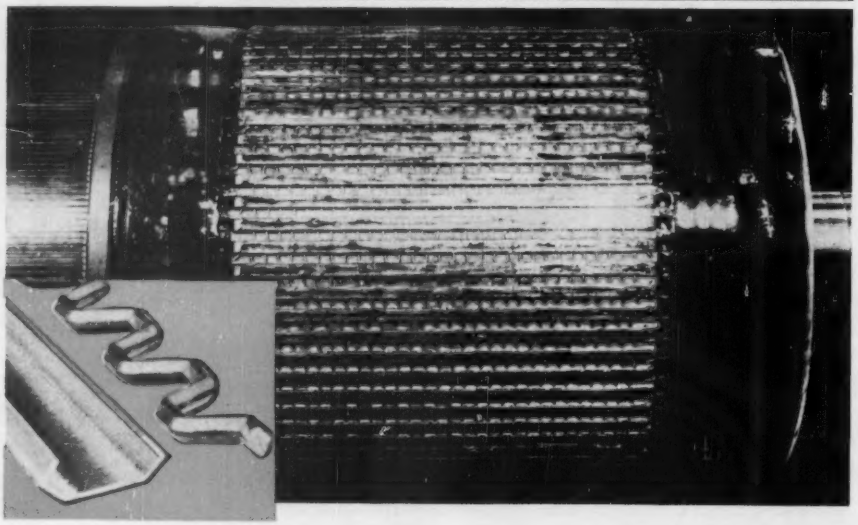


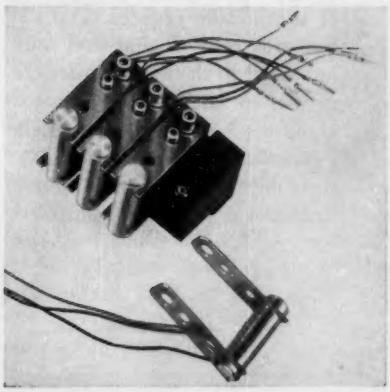


Floating linked rockers provide pushbutton interlocks that prevent simultaneous depression of two buttons. The rockers also return any previously depressed button to its normal position when any other of the four buttons is depressed. Principle employed in a switch by Control Switch Div., Controls Co. of America, Chicago, Ill.

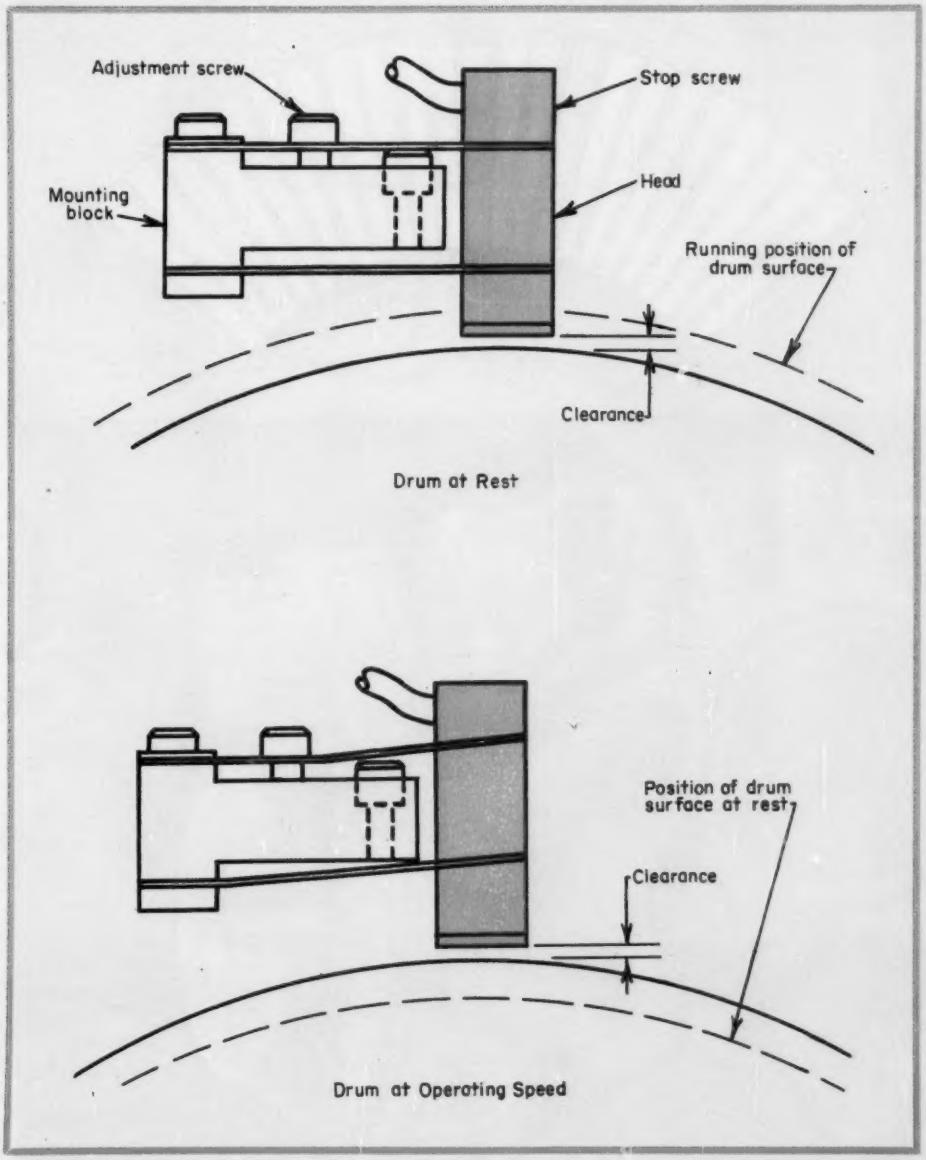
Wires increase turbulence for cooling of a railroad traction motor. Lengths of crimped wire hold the Mylar-faced, epoxy-glass laminate insulation in the rotor grooves. The thin laminate and wire combination replaces a thicker, smooth surfaced laminate stick formerly used. Principle employed in insulation by Swedlow Inc., Youngstown, Ohio.



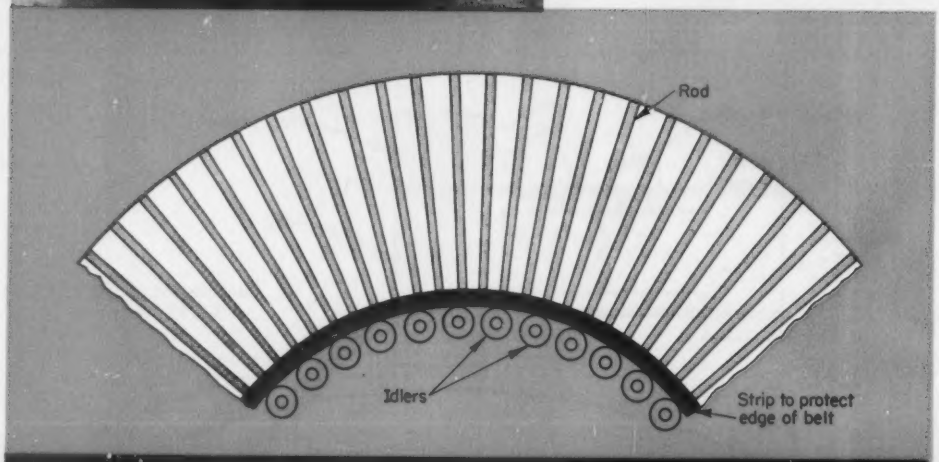


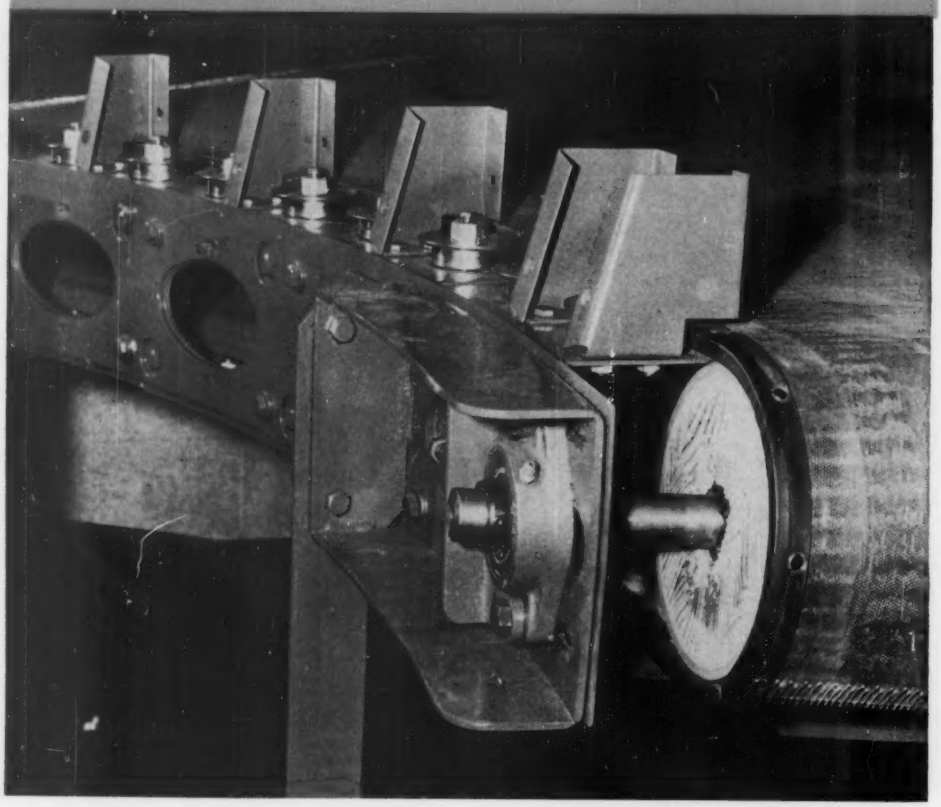


Air film supports head of a magnetic drum recorder. Air, dragged along by the rotating drum, supports the flexture-mounted head a few ten-thousandth of an inch from the drum. Thus, the required clearance is maintained, in spite of centrifugal expansion of the drum at operating speed. A stop provides clearance when the drum is stationary. Principle employed in a magnetic-drum head by Bryant Computer Products Div., Ex-Cell-O Corp., Walled Lake, Mich.

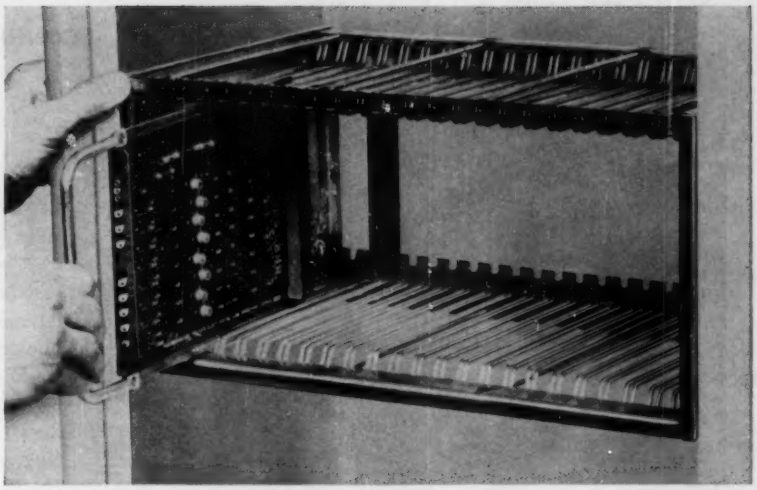


Rods prevent tearing of the outside edge of a curved conveyor belt. Radial steel rods, imbedded in the belt, transfer the stresses to idler rollers arranged along the inner edge of the belt. Principle employed in a conveyor belt by Goodyear Tire and Rubber Co., Akron, Ohio.

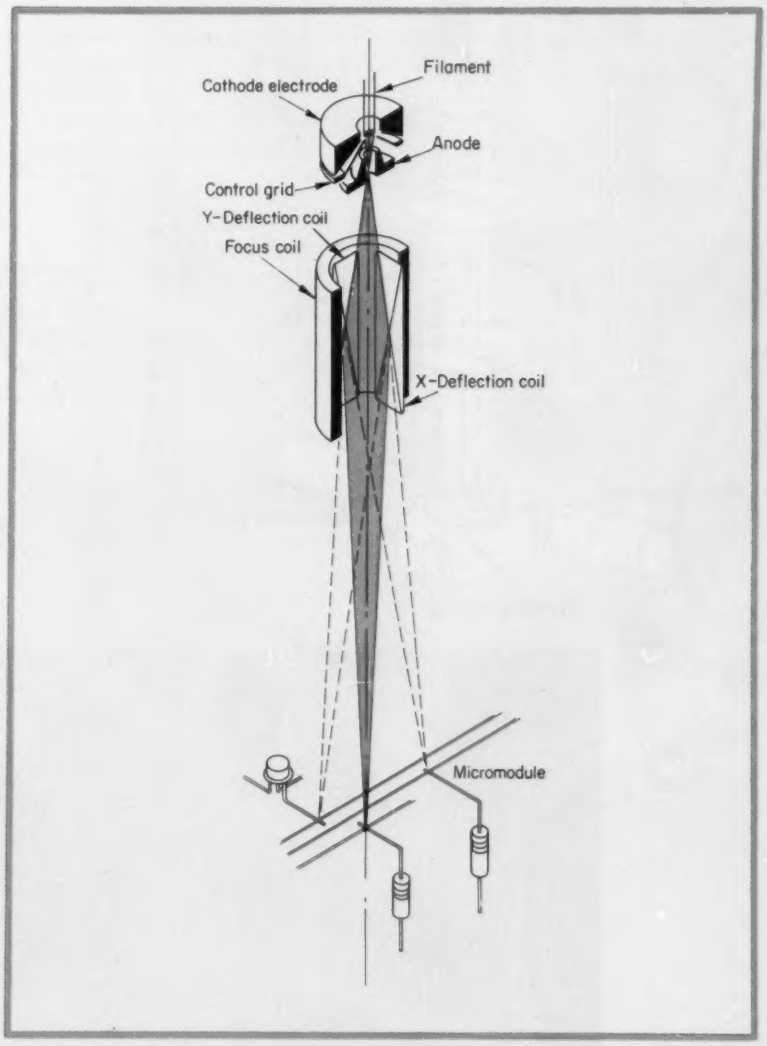




Wires support boards in a printed-circuit board holder. Accurately spaced guide wires form slots into which the circuit boards are inserted. Spring-clamping action of the wires hold the boards firmly in place. Principle employed in a holder by E. H. Titchener & Co., Binghamton, N. Y.

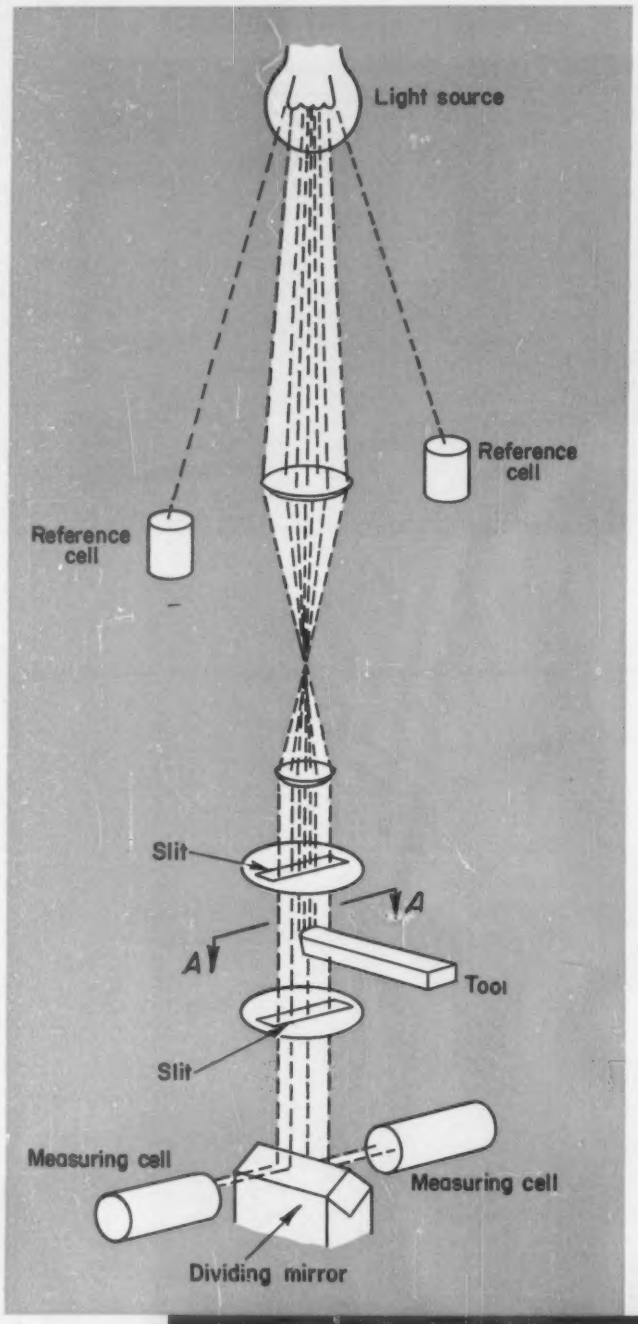


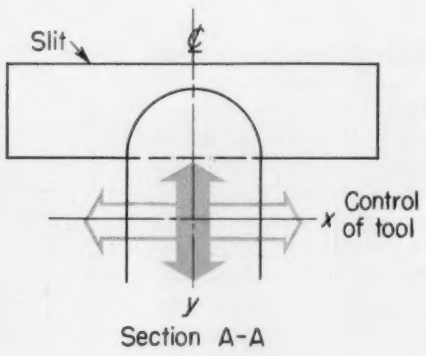
Electromagnetic lens positions beam in an electron-beam welder. A focused beam of electrons, emitted from a hot metal filament, is deflected by the application of control current to the X and Y-direction deflecting coils. Thus the position of focal point of the beam can be controlled electrically in all three dimensions. Principle employed in an electron-beam welder by GVC Electron Heating Corp., Medford, Mass.

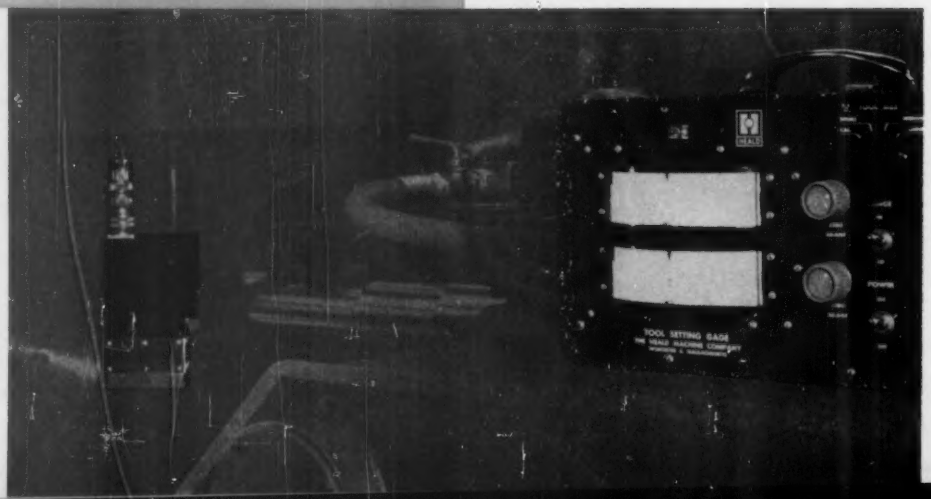


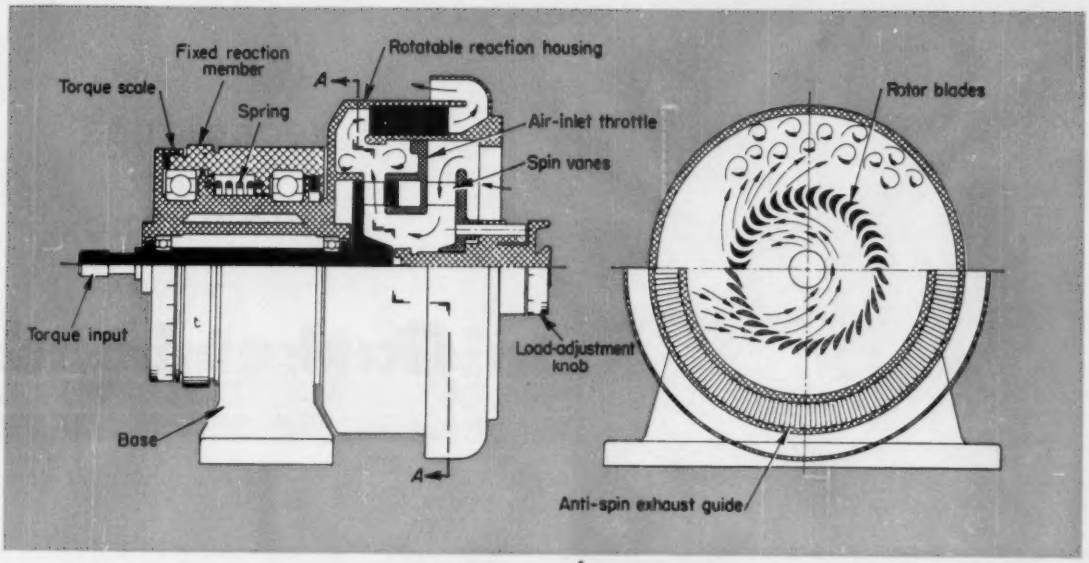
SCANNING THE FIELD FOR IDEAS

Light-area comparison provides precise 2-plane measurement in tool setting gage. Displacement of the tool in the X-direction produces a differential output from the measuring photocells. Displacement in the Y-direction produces a differential output between the measuring photocells and the reference photocells. Principle employed in a tool setting gage by Heald Machine Co., Worcester, Mass.



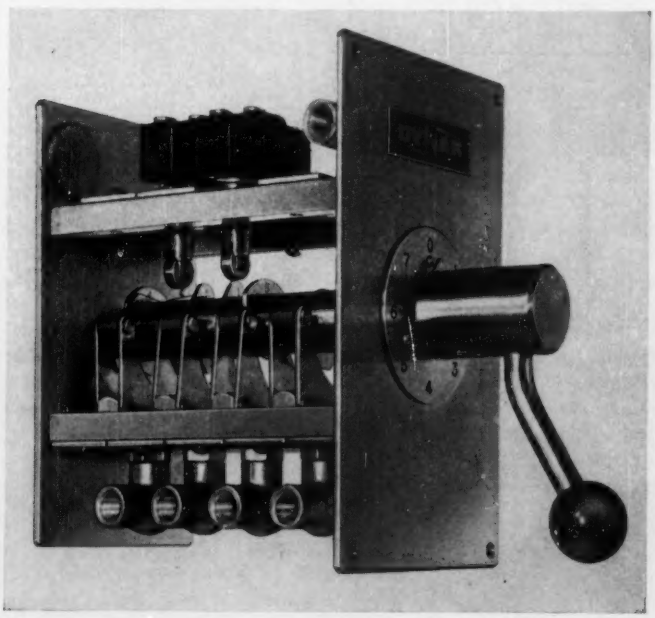


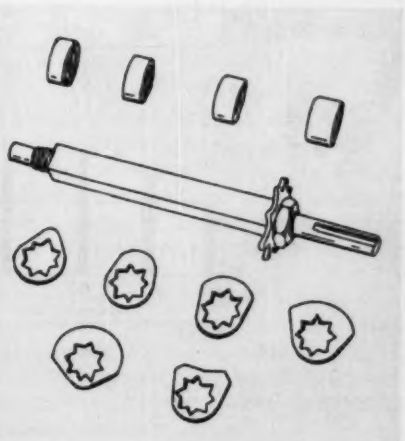




Air is working fluid in a high-speed dynamometer. Atmospheric air is forced into the discharge chamber by the rotor. Air turbulence produces a torque reaction which is measured by the windup of a helical spring. To prevent torque reaction from rotation of the discharge stream, the air is discharged through straightening vanes. Principle employed in a dynamometer by Hydro-Mill Co., Santa Monica, Calif.

Eight-position cams provide selective programming of sequence of events with single-knob manual control. The series of individually mounted cams act in predetermined sequence upon valves or switches as the knob is turned stepwise through 360 deg. Principle employed in a process programmer by Dynak Inc., Rochester, N. Y.





techniques
for
evaluating

Gasket Loads

I. G. NOLT
and
E. M. SMOLEY
Research and Development Center
Armstrong Cork Co.
Lancaster, Pa.

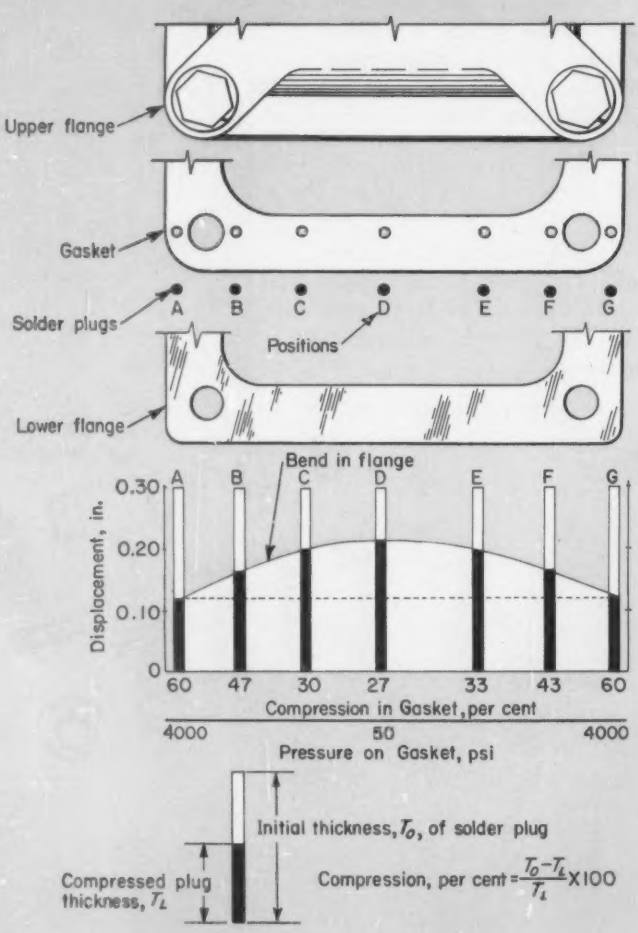


Fig. 1—Elements of the solder-plug compression test.

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in Flanged Joints

FLANGE design, gasket selection, and leakage analysis are improved by four techniques for evaluating flange pressure factors. The newest of these techniques is based on the application of a strain gage incorporated into a flat washer. In this way, bolt torque can be translated directly into bolt load. This article describes the new technique and the three other methods: The solder plug compression test, the translation of bolt torque into gasket load, and the measurement of bolt elongation.

All nonmetallic gaskets require certain minimum or threshold loading conditions to create a seal. Moreover, a maximum in torque retention is dependent upon the proper gasket loads. Almost every aspect of gasket performance is related to the flange-pressure factor. Therefore, application of the techniques for evaluating flange pressure is necessary for effective flange design. These same techniques aid in analyzing test data obtained in actual performances or service tests.

Solder Plug Compression Test

Although a flanged joint is a complex load-compression machine, unit compressive loads on the gasket can be found in almost any existing flanged assembly. This is made possible by the solder plug test which permits a measurement of gasket compressions under actual application conditions.

Assume, in Fig. 1, that gasket compressions are to be evaluated at points A, B, C, D, E, F, and G. At such points, small holes about 1/16 in. diam are punched through the gasket, using an ordinary leather punch. Soft solder plugs are placed in these holes. The gasket-plug combination is then installed in the joint assembly and the bolts are tightened to their preselected torque. The plugs need not be exactly as thick as the uncompressed thickness of the gasket, but they must be thick enough to be capable of further compression when the gasket itself has been fully compressed between the flanges. Since soft solder is inelastic, the plugs remain at the compressed thickness of the gasket when a joint is disassembled. A typical plot of data is shown in Fig. 1.

Once the compressed thickness is known, from plug measurements, it is easy to calculate gasket compressions according to the equation in Fig. 1. Unit compression loads required to produce such compressions are found from a load-compression curve obtained on the gasket alone.

Sometimes, in a flanged assembly of complex shape, it is difficult to determine intuitively the

regions where it would be desirable to locate the solder plugs. In such cases, a preliminary test can be made in which carbon paper is sandwiched between a sheet of white paper and the gasket in the flanged assembly. The resulting carbon pattern on the white paper indicates the general load distribution over the entire gasket area.

Kinds of information obtainable from a solder plug test are:

1. Gasket compressions
2. Unit compressive loads required to produce these compressions
3. Flange distortion
   a. Bowing or bending
   b. Nonparallelism
4. Whether or not the gasket had been exposed to its minimum initial loads for sealing

A plug test can be extremely useful in analyzing gasket loads and compressions in flanges which leak. Normally, leaks appear at the points of maximum flange bending which is usually midway between two adjacent bolts—point D, in Fig. 1. Here the gasket loads are not high enough to make a seal. To increase the load at this critical point, three remedies might be considered: 1. Increase the initial bolt torque. 2. Increase the number of bolts. 3. Increase the flange thickness.

Increasing initial bolt torque tends to increase the amount of bending. However, there is usually a slight increase in gasket loading at the point of maximum bowing. This increase might be just enough to close a leak. Of course, if the bolt is already operating near its yield torque, further increases in torque cannot be made unless bolts with higher yield properties are used or the bolt size is increased. From simple elastic beam theories, flange deflection should be proportional to the cube of the span between bolt centers. Consequently, an added bolt, placed at the point of maximum bowing, will cut the span by one half and at the same time reduce the flange deflection by one eighth. This, too, could result in a significant improvement in the seal, probably more so than increasing the initial torque on the bolts. Increasing the flange thickness by a factor of two may produce the same effect, because elastic beam theory states that maximum flange deflection is inversely proportional to the cube of flange thickness.

If it is impossible to alter bolt torque settings or flange design, two possibilities might be considered from the standpoint of the gasket material itself:

1. Change the gasket material. The direction to take is toward lower minimum sealing load. Give preference to gaskets whose sealing minimums are less than the flange load at the point of maximum flange deflection.

2. Change the uncompressed thickness of the gasket. The uncompressed thickness has a strong bearing on the degree of seal attained, particularly if the flange loading conditions fall below those normally recommended. On impervious gaskets, such as cork and rubber, increase in thickness may greatly improve sealing, especially in joints where the gasket is too thin to compensate for flange distortions. This also holds true for porous materials like cork composition and some fibers. However, thickness increases on a porous gasket can be carried too far. There is a point above which sealing becomes worse because the porosity of the gasket itself determines the degree of seal. There is an optimum gage for a porous gasket, but it is hard to find except by actual application tests.

Gasket Loads from Bolt Torques

Bolt torques can be translated into bolt loads according to the relationship,

$$T = 0.2\,DL$$

This is an empirical relation based on a torque-load study covering a number of bolts of various sizes and diameters. When the bolt load is known and when it is assumed that the flanges distribute the bolt loads uniformly over the gasket area, a flange pressure can be calculated thus:

$$\frac{NL}{A} = \text{Apparent flange pressure, psi}$$

The calculated flange pressure is referred to as *apparent* flange pressure because the calculated value must be corrected for bolt friction. Bolt friction is the sum total of friction between the bolt head, flange, and the mating screw threads. The equation $T = 0.2\,DL$ takes some but not all of these factors into consideration. In the Armstrong Research Laboratories, the problem was approached by selecting from the gasket-using industries a sample of various joint designs in which the designer had already incorporated the friction factor. On each flange comprising the sample, the apparent flange pressure was statistically correlated with the actual flange pressure imposed on the gasket. A statistical relationship between these two quantities

Nomenclature

A = Area of gasket, sq in.
A_1 = Sectional area, unthreaded portion of bolt, sq in.
A_2 = Mean-stress sectional area of threaded length of bolt, sq in.
D = Nominal diameter of bolt, in.
E = Bolt modulus of elasticity (30×10^6 for steel), psi
L = Load per bolt, lb
L_B = Bolt load, lb
N = Number of bolts
T = Torque, lb-in.
ΔL = Bolt elongation, in.
l_1 = Length of unthreaded portion of bolt, in.
l_2 = Bolt threaded length which is under tension, in.

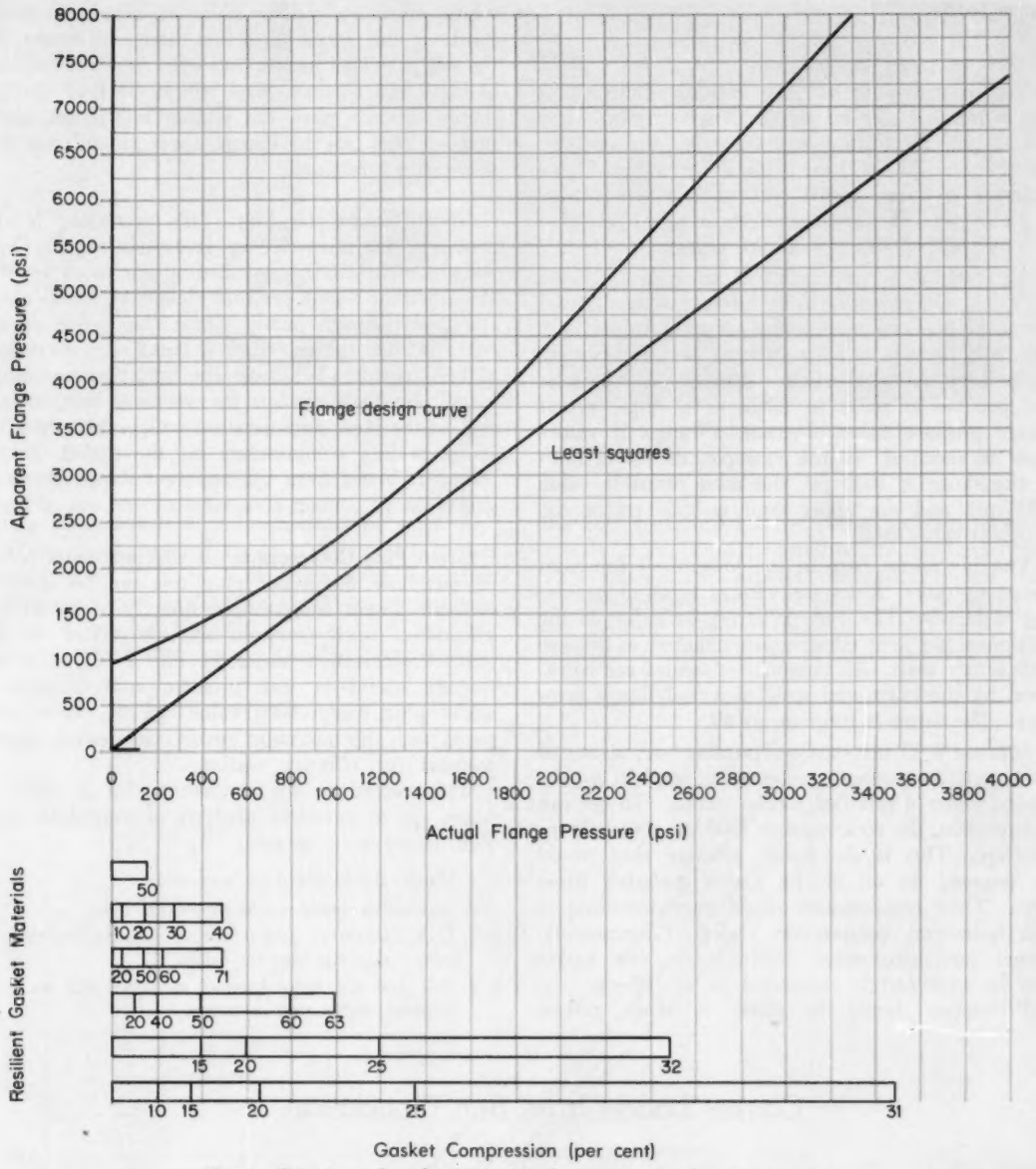


Fig. 2—Selection of gasket materials from apparent flange pressure.

is seen from the curves in Fig. 2, and it can be interpreted qualitatively in terms of bolt friction. The curved line, for example, is to be associated with dry, dirty, rusty, unlubricated bolts—that is, a high amount of friction. Under these conditions, most of the applied bolt torque goes into overcoming this friction, very little being available for gasket compressions. The straight line represents the most probable friction, which is extremely difficult to define. However, it might be regarded in terms of the friction that a designer will most likely put into a flanged assembly.

How Fig. 2 might be used in flange design, gasket selection, and leak analysis can be demonstrated in three basic problems:

1. Given the initial bolt torque settings on a joint, find the actual gasket loading conditions.
2. Given the actual gasket loading conditions, in particular a minimum load to create a seal, find the initial bolt torques required to achieve such conditions.
3. Given a solder plug compression value, find whether or not it is above or below the minimum sealing compressions.

Given Bolt Torque: Suppose a flat-faced joint design contains four 5/16-18NC bolts each torqued to 180 lb-in., the gasket-flange contact area being 3.24 sq in. The apparent flange pressure is

$$\frac{NT}{0.2\,DA} = \frac{4(180)}{0.2(5/16)(3.24)} = 3556 \text{ psi}$$

where T is the initial torque.

In Fig. 2, 3556 psi is located along the vertical or apparent flange pressure scale. From the design

curve, it is found that the corresponding actual flange pressure on the actual flange pressure scale is 1600 psi. Since the design curve is based on high bolt friction, the 1600 psi is the lowest actual flange pressure to be associated with the apparent value of 3556 psi. The average or most probable value is 1900 psi, obtained from the straight line.

Although it is not indicated in Fig. 2, if the bolts are exceptionally well lubricated, the actual flange pressure may equal the apparent value itself. But bolt friction is both variable and exceedingly difficult to define precisely. Because of this, it is not possible to speak in terms of a single actual flange pressure value. Instead, a range of values must be specified. In this example, the lower limit of the range is 1600 psi, the most probable value 1900 psi, and the upper limit is 3556 psi or the apparent value itself.

The horizontal bars in the lower half represent the compression scales for various types of gasketing materials. The end point on each bar is the minimum per cent compression required to achieve satisfactory seals. All compression scales are correlated by the horizontal scale of actual flange pressure. The latter is common to all.

Suppose a 63 per cent compression was measured in a cork composition gasket when used in a joint design under a specified torque setting. To get this compression, the cork requires 1000 psi actual flange pressure. This is the flange pressure that would be imposed on all of the gasket materials listed here. Their compressions would vary according to the horizontal compression scales. Consequently, actual load-compression condition on one gasket can be conveniently translated to all others.

Preference should be given to those gaskets whose minimum sealing loads are below the lower limit on the range of actual flange pressures for the design. This means that even under conditions of high bolt friction, there will be at least enough flange load to meet the sealing minimums specified on the gasket. Flange loads should not fall below this minimum.

Given Gasket Loading: This procedure is the reverse of the procedure for given bolt torque. Once the gasket is selected and loading minimum known, the apparent flange pressure should be found using the flange design curve. Since the flange design curve is used, the procedure is based on a maximum of bolt friction. Whatever the initial torque value, it will be high enough to overcome bolt friction and, at the same time, produce no less than the minimum sealing compressions on the gasket. Initial torque is found from the apparent flange pressure, gasket-flange contact area, number and size of bolts.

Given Plug Compression: It was previously pointed out how the solder plug test can be used to evaluate gasket compressions directly in actual applications. Such compressions are related to the gasket compression scales in Fig. 2. This is extremely useful in leak problem analysis since a solder plug compression value can be easily compared with the minimum gasket compression recommended for effective sealing.

This procedure for estimating flange loads is based on a statistical analysis of empirical data. Restrictions on its use are:

1. Flanges should not distort excessively.
2. Thread fits should not be abnormally tight.
3. Lock washers or similar devices affecting the tightening torque may alter the values.
4. Bolt sizes can range from ¼ to ¾ in. and can be threaded, either fine or coarse.

Gasket Loads from Bolt Elongation

When bolts are tightened, they undergo stretch or elongation. This elongation can easily be measured with an ordinary micrometer, particularly in joint designs employing through-bolts. In any event, when bolt elongation is known, the corresponding bolt load can be found from:

$$L_B = E \frac{\Delta L}{\frac{l_1}{A_1} + \frac{l_2}{A_2}}$$

This equation is derived directly from the stress-strain properties of the bolt. Once the bolt loads are known the calculation of unit compressive stresses becomes a simple problem. Although this technique would be difficult to incorporate in a flange design procedure, it still remains, at least in principle, an accurate means for estimating unit gasket loads.

Gasket Loads from Washer-Type Force Gages

The new electromechanical technique for measuring actual flange pressure is based on the application of a washer-type force gage marketed by Lockheed Electronics Co., Los Angeles, Calif. The similarity between the force gage and an ordinary flat washer can be seen in Fig. 3. The principle of operation depends upon the small increase in circumference of the gage caused by the application of a compressive load. This increase in circumference is reflected as a change in the resistance

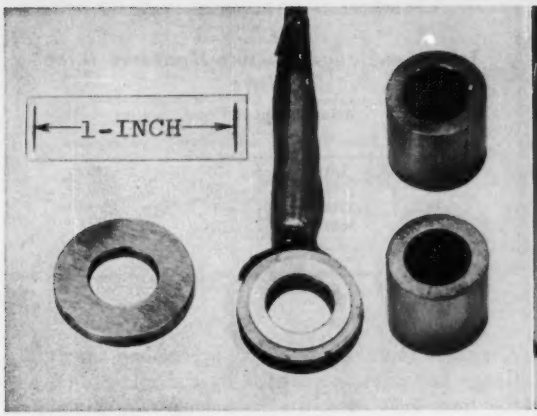


Fig. 3—Components of a washer-type force gage.

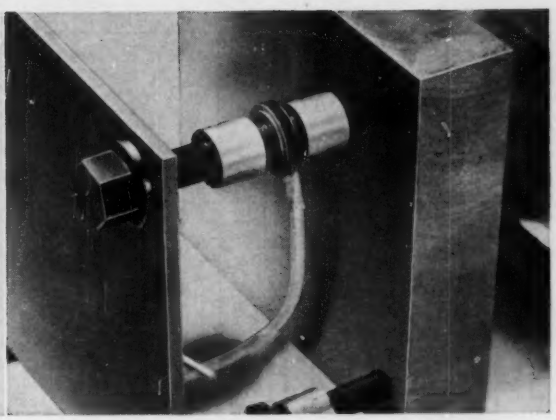


Fig. 4—Washer-type force-gage assembly.

of the strain-sensitive wire encircling the gage.

Force gages are available in a variety of bolt sizes ranging from 3/16 to 1 in. diam with maximum compressive loads of 5000 to 35,000 lb, respectively. Fig. 4 shows the installation of a 5/16 in. diam force gage in a test flange. The flat plate between the bolt head and loading sleeve prevents torsional stresses from being transmitted to the force gage. This arrangement exposes the gage to pure compressive stresses which, of course, are produced by the tightening torques applied to the bolts. The electronic circuit required to detect the bolt loads is

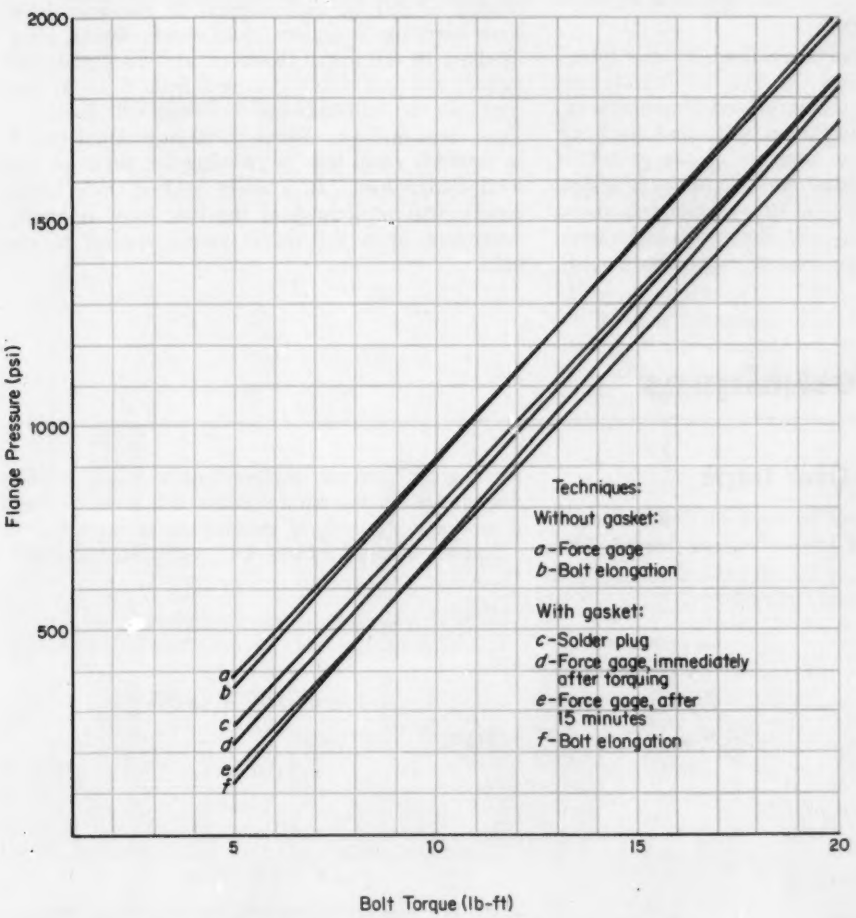


Fig. 5—Flange pressure and bolt torque in force-gage technique.

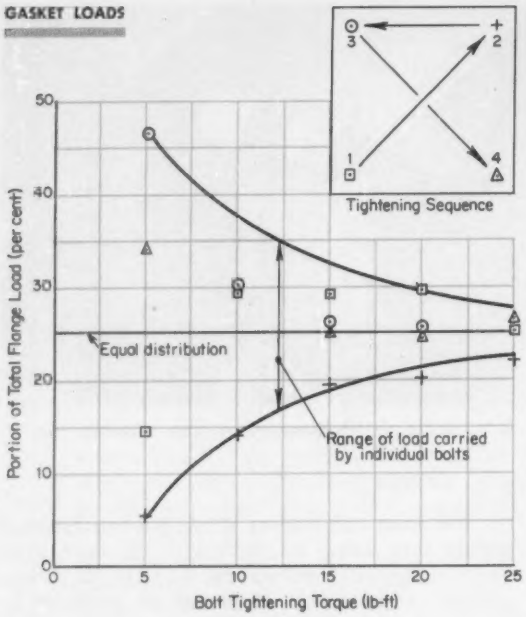

Tightening Sequence
Portion of Total Flange Load (per cent)
Bolt Tightening Torque (lb-ft)
Equal distribution
Range of load carried by individual bolts

Fig. 6—Distribution of flange load.

a typical strain gage circuit.

Some typical test results obtained by the force-gage technique are given in Fig. 5. Initial bolt torque as read from an ordinary hand torque wrench is plotted along the horizontal scale and the corresponding actual flange pressure of the gasket is indicated along the vertical scale. Without a gasket installed in the test flange, curves *a* and *b* show that the force gage and bolt elongation techniques agree very well. As can be seen from curves *c*, *d*, *e*, and *f*, there is also good agreement among the flange pressures determined by the solder-plug test, the force-gage, and the bolt-elongation techniques. When a gasket is used, the latter two techniques give flange pressures which are a little lower than those determined without a gasket because of the phenomenon of stress relaxation. Table 1 shows the degree of correlation among these three methods.

Table 1—Flange Pressure Measured Three Ways

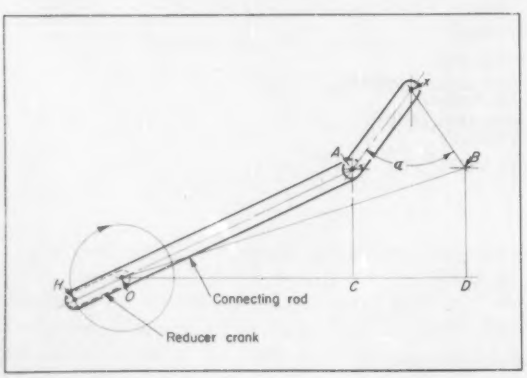
Tightening Torque (lb-ft)	Actual Measured Flange Pressure (psi)		
	Force Gage	Solder Plug	Bolt Elongation
5	221	254	155
10	721	779	659
15	1371	1387	1266
20	1856	1830	1865

As a corollary to its use in measuring flange pressures, the force gage opens up a new area of the gasket problem. It deals with evaluating bolt load variations as they relate to the sequence in which the bolts are tightened around a gasketed joint. For example, Fig. 6 shows progressive distribution of bolt loads in a square test flange containing a bolt in each corner. If the four bolts were carrying a uniform load, each would carry its share of the total. However, at 5 lb-ft of initial torque, the bolt loading ranges from 5 to 47 per cent. As the initial torque increases, bolt loads become more uniform. When 25 lb-ft of initial torque is reached, each bolt is carrying its share of the total flange load. It is quite evident, from these results, that uniformity of the bolt loads is highly dependent upon the initial torque applied to the bolts.

Tips and Techniques

Reducer-Crank Length

A simple method may be used to find reducer-crank length *OH* and connecting-rod length *AH* for a given angular displacement α, where a 360-deg rotation of the reducer crank will give one complete operating cycle of member *Ax* about *x*.



Known dimensions are *OC*, *OD*, *AC*, and *BD*. From this, find

$$OA = \sqrt{(OC)^2 + (AC)^2}$$

and

$$OB = \sqrt{(OD)^2 + (BD)^2}$$

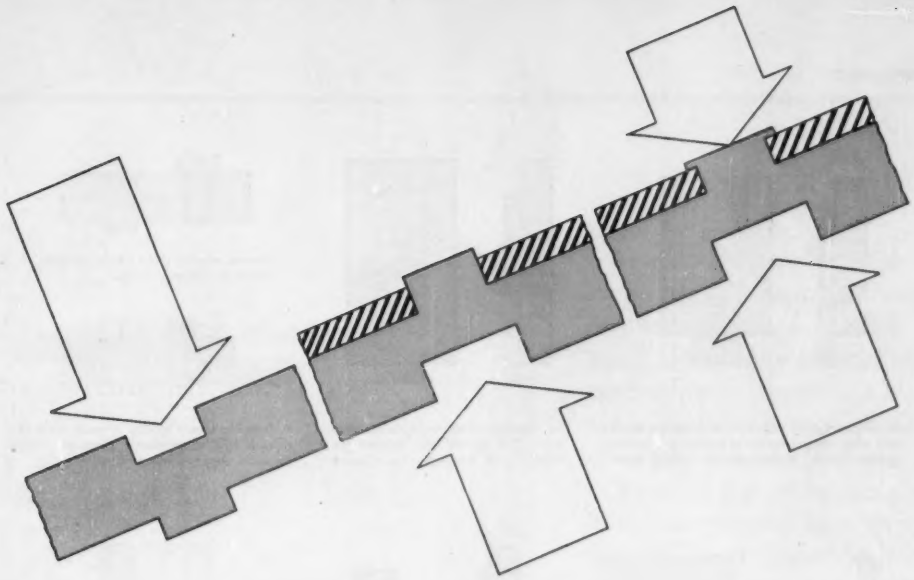
Then,

$$OH = \frac{OB - OA}{2}$$

and

$$AH = OB - OH$$

—W. W. Shostek, *United States Steel Corp., Johnstown, Pa.*



Design tips for using

Dowel Embossings

FEDERICO STRASSER
Mankewitz and Strasser Ltd.
Santiago, Chile

ONE of the simplest and cheapest methods of making a dowel connection in sheet metal is by using dowel embossings. These can, in many cases, replace standard dowels, and have a number of uses of their own.

This article illustrates some of the ways in which dowel embossings can be used. Many variations are, of course, possible.

The most common tool used in making dowel embossings is the standard punching die, Fig. 1*a*. However, this method restricts dowel height, since shear occurs quickly.

Allowable punch penetration depends on the fol-

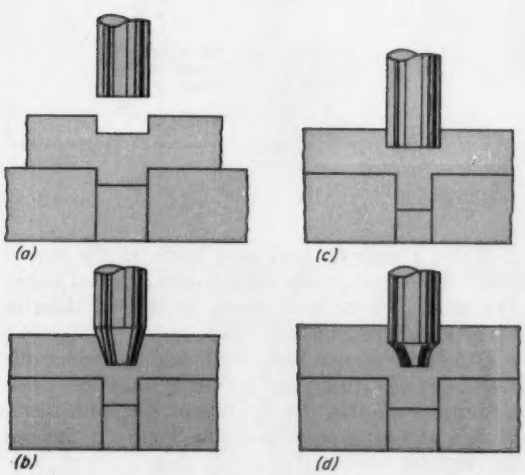


Fig. 1—Various die shapes for producing dowel embossings: *a*, standard die; *b*, tapered die; *c*, oversize die; *d*, stepped die.

Table 1—Maximum Punch Penetration Before Shearing

Metal Thickness (in.)	Punch Penetration (per cent of material thickness)
1/32	87
1/16	75
3/32	67
1/8	62
3/16	56
1/4	50
5/16	47
3/8	44
1/2	37
5/8	34
3/4	31
1	25

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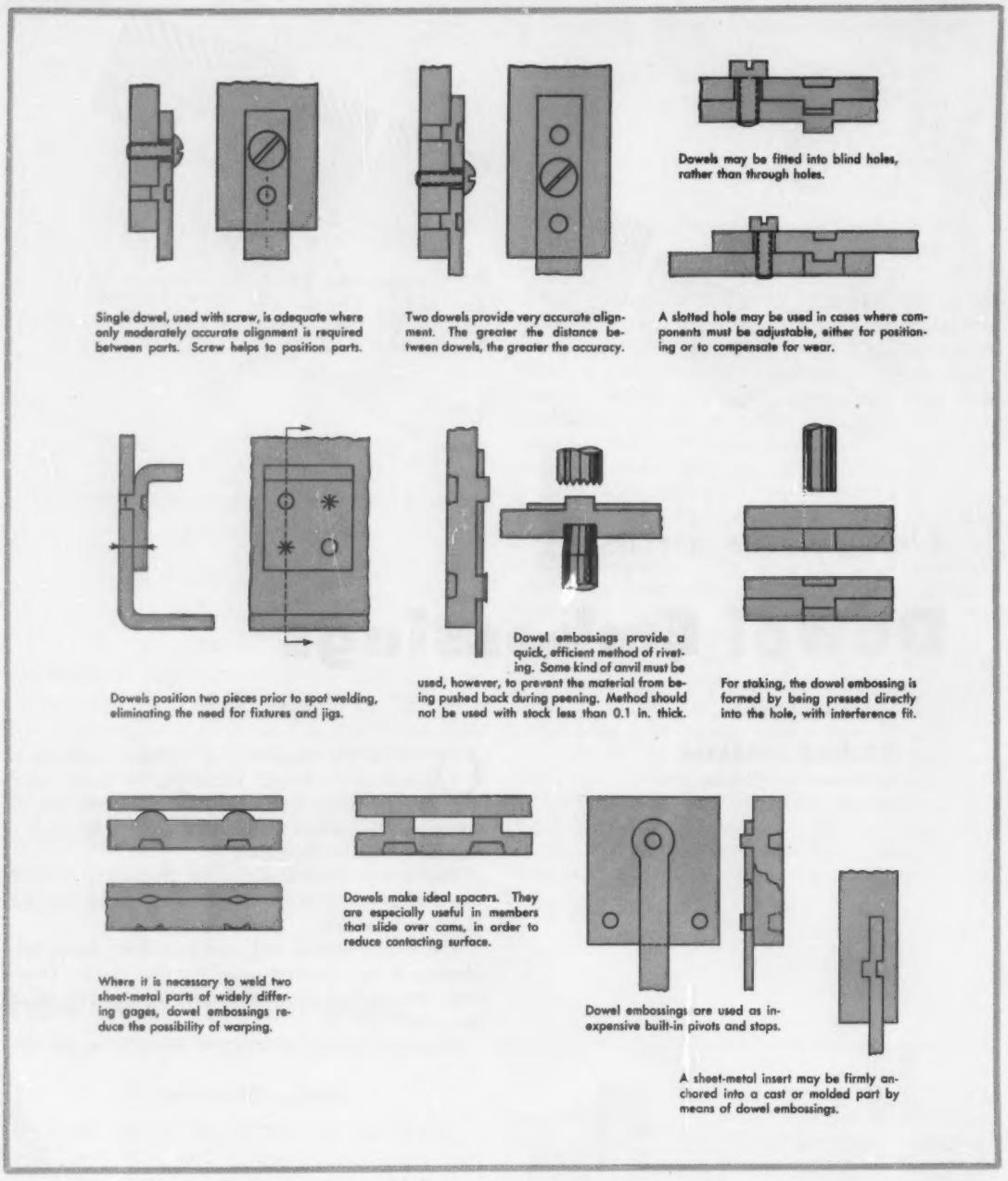


Single dowel, used with screw, is adequate where only moderately accurate alignment is required between parts. Screw helps to position parts.

Two dowels provide very accurate alignment. The greater the distance between dowels, the greater the accuracy.

Dowels may be fitted into blind holes, rather than through holes.

A slotted hole may be used in cases where components must be adjustable, either for positioning or to compensate for wear.

Dowels position two pieces prior to spot welding, eliminating the need for fixtures and jigs.

Dowel embossings provide a quick, efficient method of riveting. Some kind of anvil must be used, however, to prevent the material from being pushed back during peening. Method should not be used with stock less than 0.1 in. thick.

For staking, the dowel embossing is formed by being pressed directly into the hole, with interference fit.

Where it is necessary to weld two sheet-metal parts of widely differing gages, dowel embossings reduce the possibility of warping.

Dowels make ideal spacers. They are especially useful in members that slide over cams, in order to reduce contacting surface.

Dowel embossings are used as inexpensive built-in pivots and stops.

A sheet-metal insert may be firmly anchored into a cast or molded part by means of dowel embossings.

lowing factors: 1. Penetration decreases as ductility decreases. 2. Penetration decreases as hardness increases. 3. Penetration decreases as thickness increases. 4. Penetration increases as punch clearance increases. 5. Penetration increases as d/t ratio decreases (d = diameter of punched hole; t = thickness of material). 6. Penetration increases as cutting edges become duller.

For mild steel, the punch-penetration data shown in Table 1 may be used as a guide to the size of dowel embossing possible with a given gage of metal. The punch die must of course be stopped short of the maximum penetration shown.

To obtain greater boss depth and to reduce the chance of shearing, the following may be used: 1. Tapered die, Fig. 1*b*. 2. Oversize die, with diameter 25 per cent greater than hole, Fig. 1*c*. 3. Stepped die, Fig. 1*d*.

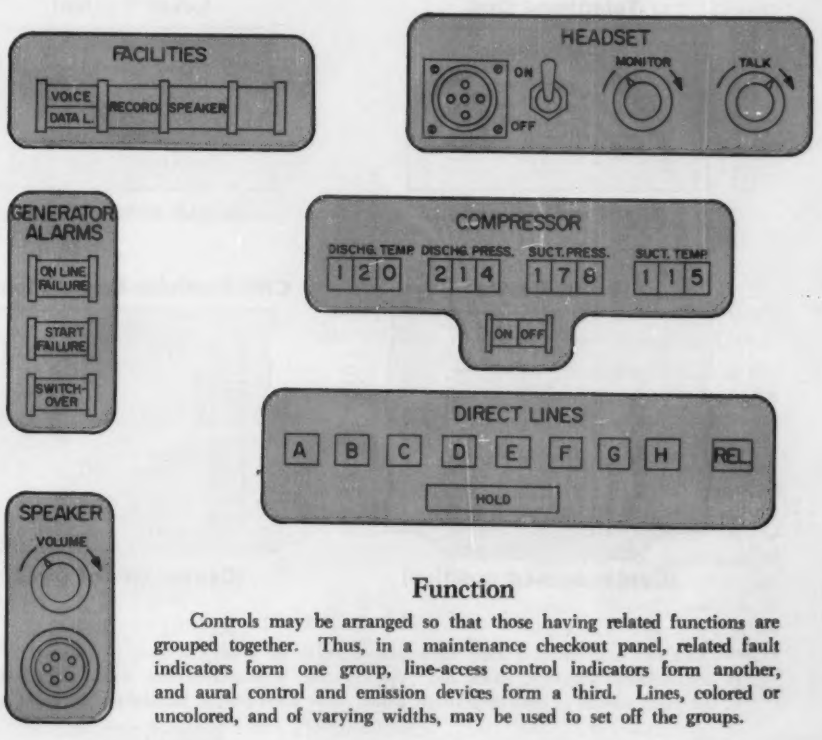
Five different ways to optimize

Control-Panel Design

WALTER J. KNUEPFER
Systems Utilization Scientist
Kellogg Communications Systems Dept.
Div. of ITT Corp.
Chicago, Ill.

Five basic approaches can be taken to the problem of positioning controls and displays on a control panel. They may be positioned according to 1. Function. 2. Importance. 3. Convenience. 4. Sequence of use. 5. Frequency of use.

Some of the principles discussed in this article may have to be modified to meet individual requirements; some may have to be combined. At any rate, a systematic approach to control-panel design is much more likely to lead to operating efficiency than a helter-skelter arrangement, or one based simply on attractiveness or symmetry.



Function

Controls may be arranged so that those having related functions are grouped together. Thus, in a maintenance checkout panel, related fault indicators form one group, line-access control indicators form another, and aural control and emission devices form a third. Lines, colored or uncolored, and of varying widths, may be used to set off the groups.

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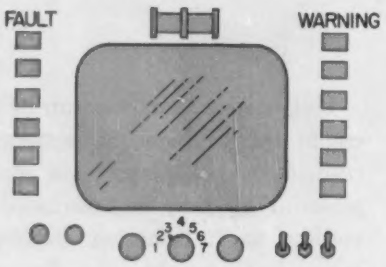
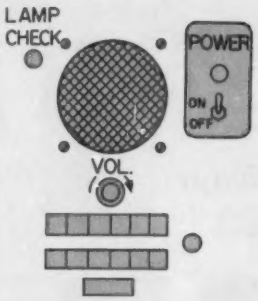
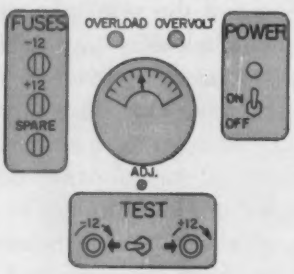
System Monitor



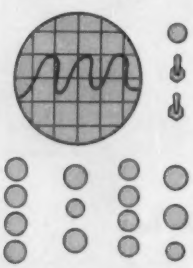
Voice Communication



Power Supply



Test Scope



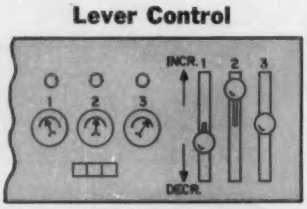
Importance

Individual or functional groups are arranged so that the most important controls and displays are placed in the most easily seen and readily accessible position. Thus, a cathode-ray tube would be placed in the center of the panel at the line of sight.

Telephone Dial

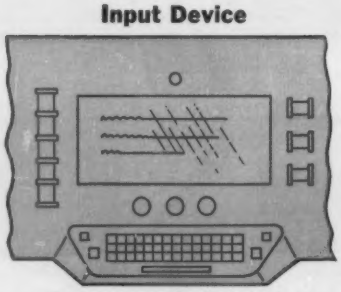
(Right side of panel)

Lever Control



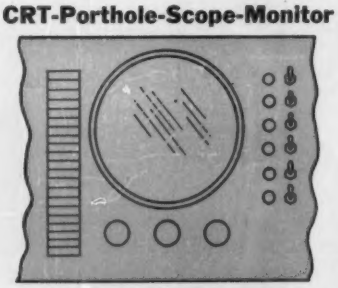
(Right side of panel)

Input Device



(Center-seated position)

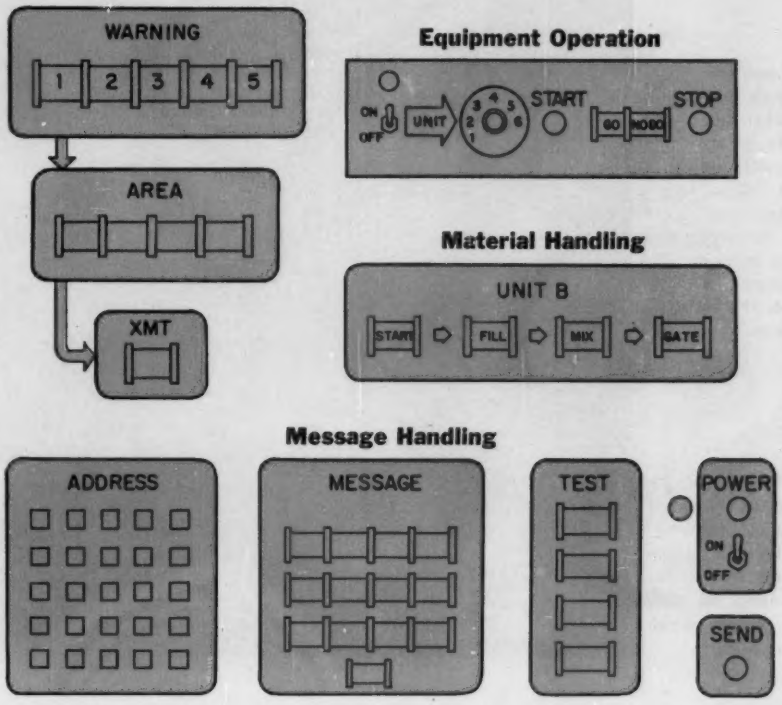
CRT-Porthole-Scope-Monitor



(Center-line of sight)

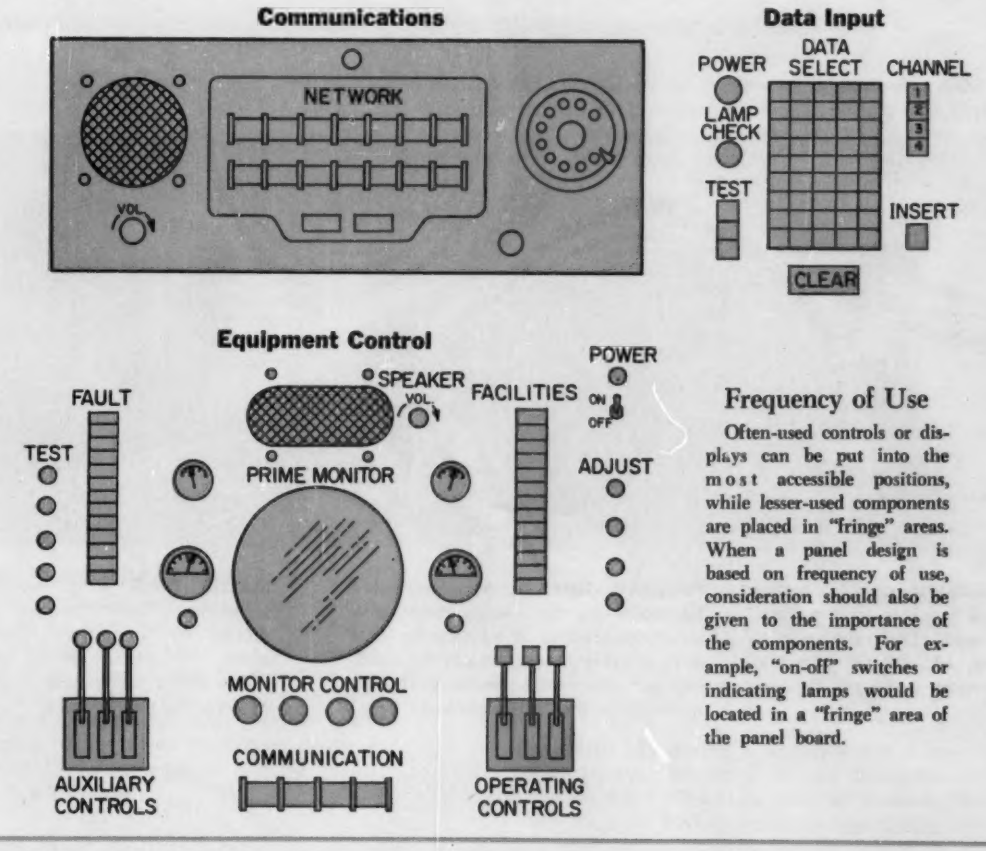
Convenience

Controls and displays may sometimes have to be placed so that the utmost is obtained in convenience, accuracy, speed, etc. For example, a telephone dial would usually be placed at the right side of a communications panel, since most people use their right hand in dialing.



Sequence of Use

Some controls and displays are operated or observed in sequence, or in a repetitive pattern; in this case, these components are arranged in order of operation. Sometimes, sequential operation is performed automatically, as in the full cycle of an automatic clothes washer.

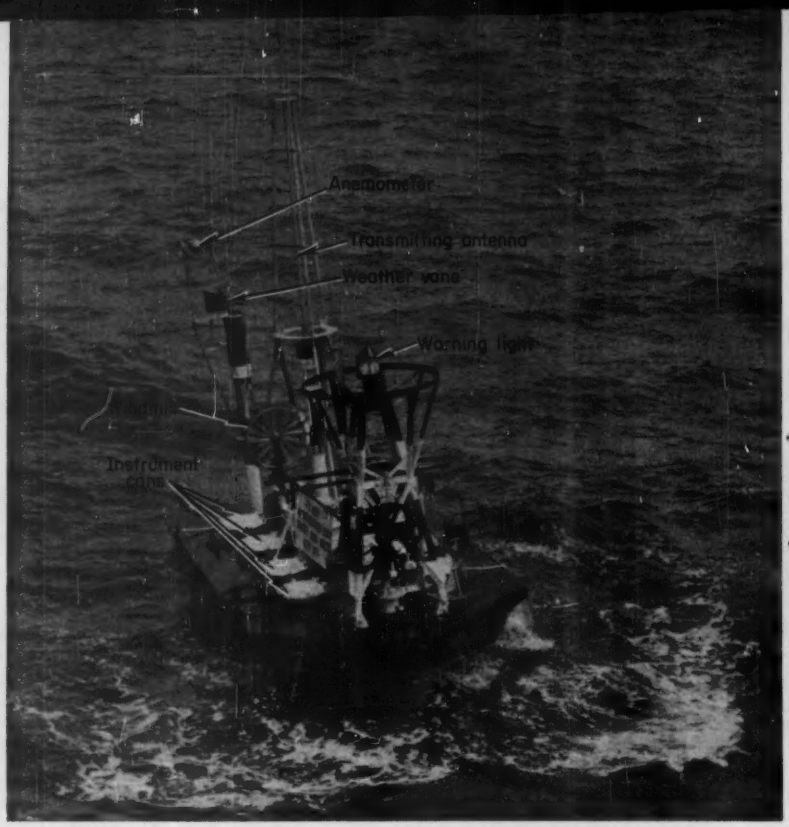


Frequency of Use

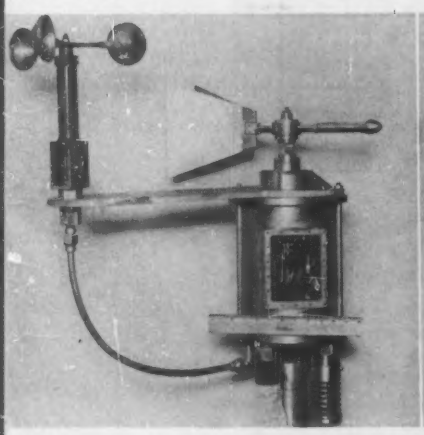
Often-used controls or displays can be put into the most accessible positions, while lesser-used components are placed in "fringe" areas. When a panel design is based on frequency of use, consideration should also be given to the importance of the components. For example, "on-off" switches or indicating lamps would be located in a "fringe" area of the panel board.

NBS Robot Weather Station

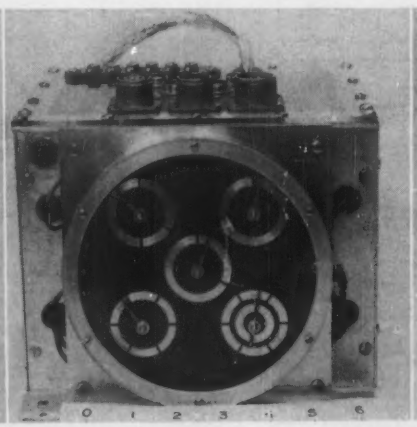
DATA on ambient weather conditions will be stored in aluminum cans sunk into the deck of a unique robot weather raft. The collected information will be broadcast four times a day to monitoring weather stations along the coast. Short-wave band is chosen to give civilian monitors a chance to participate in the program. NBS provides the code for anyone interested in reading the broadcast. A wind sensor steps up transmission rate to once per hour during heavy blows.



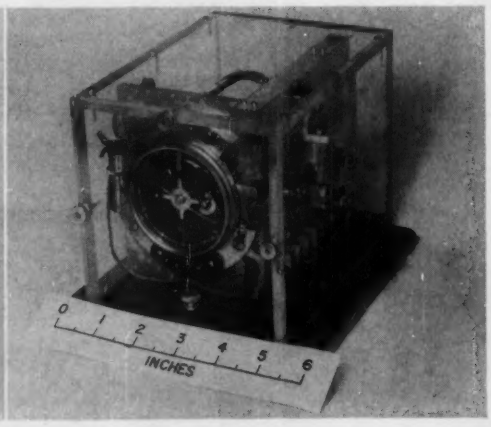
ABOVE-DECK equipment for the station includes anemometer, weathervane, windmill for recharging storage batteries, transmitting antenna, and warning light for shipping. Cans to hold electronic and data-processing gear are ranged along the deck to the left. Solar cells may replace windmill-driven generator in future ships.



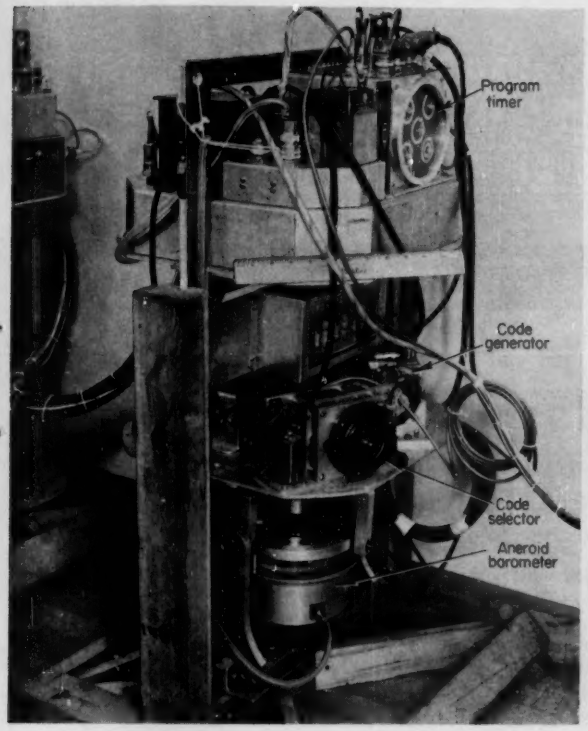
WEATHERVANE and compass are mounted together, and a transducer reads their relative position as an electric potential. Anemometer reading is similarly coded.

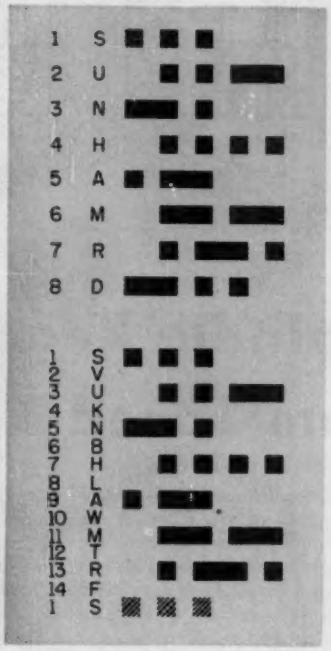


PROGRAM TIMER is actuated every six hours by the master timer and schedules readout of instruments. Five dials provide brush contacts for reading out information stored by instruments since the last broadcast.



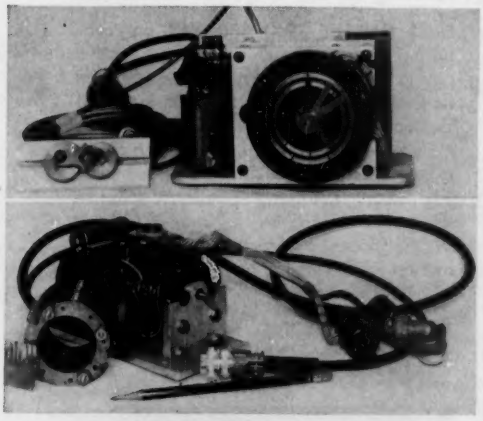
MASTER TIMER is a standard chronometer with the dial replaced by an etched contact plate. An electric motor uses the station's d-c power system to keep the timer wound.





TRANSMITTER takes 5 minutes to send information over 14 channels. International Morse Code is used on six channels (upper code) to transmit station identification and five weather items—air and water temperature, wind speed and direction, and barometric pressure. Tone-variable pulse-rate signals (lower code) are produced by bridging contacts to give information on wind and sunshine since last transmission, and direction of surface current.

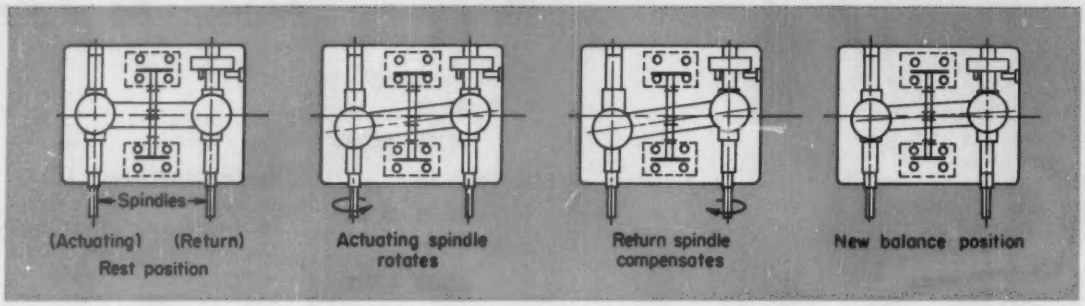
Transmits Sea Data Stored in Cans



CODE GENERATOR is built of alternating contact and insulating rings. Code contacts are cut on inner edge of each ring—three identical letters to a ring. The rings are cut into three segments and separated by insulators. Terminal lugs attached to each segment connect with leads from the code selector. Motor-driven brush scans the inner surface of the generator to pick off signals on closed circuits.

INSTRUMENTS translate data into electrical resistances which are incorporated in a self-balancing a-c bridge. The bridge operates a code selector which picks out letters to make 3-letter words. Morse code is on the inner track. Bridging contacts make tone-variable pulse-rate signals on the outer track.

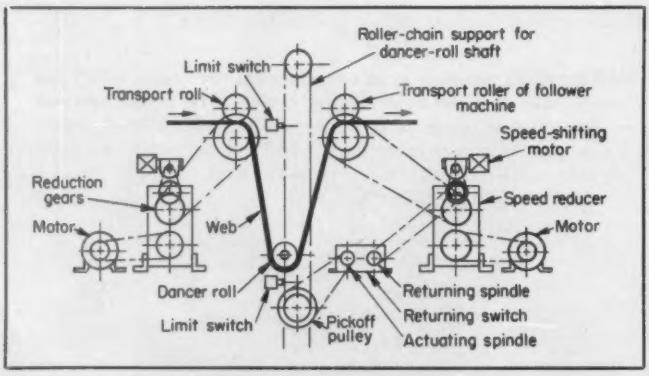
ANEROID BAROMETER is equipped with a transducer that changes resistance as the barometer varies. This resistance is connected to a self-balancing bridge that transmits the information through a code selector.

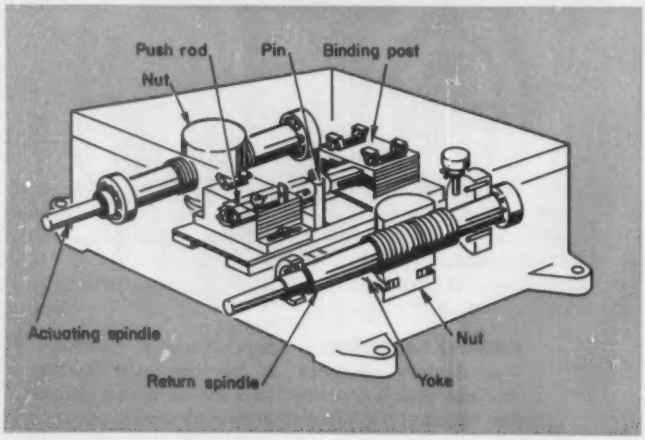


Servo Spindle Reads Feedback From Speed Reducer

MECHANICAL servo switch follows the demands of a varying input and adjusts output to keep pace through an infinitely variable speed reducer. Here's how it works in one application:

A web of cloth passes from one machine to another. Because of variations in roll thickness, slippage, wear, etc., the relative speeds of the two machines will have to vary somewhat to keep the web at a constant tension. A dancer roll rides on the loop between the two machines, and its motion up and down is transmitted mechanically to the actuating spindle of the switch. Contacts operate an electric motor that changes ratio of the speed reducer in the follower machine. Compensation is limited by the return spindle of the switch which is coupled to the electric motor.

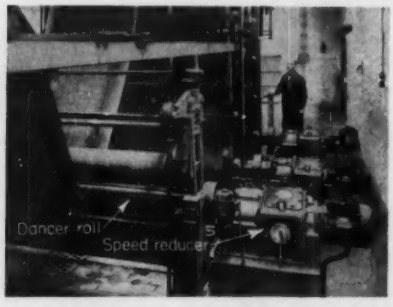




DANCER ROLL is supported by the web of material between two machines. Its motion up or down as the material tightens or slackens is transmitted to the mechanical servo by the pickoff pulley. The actuating spindle operates a switch to start the speed-shifting motor. Feedback from the speed-shifting motor causes the returning spindle to shut off the switch.

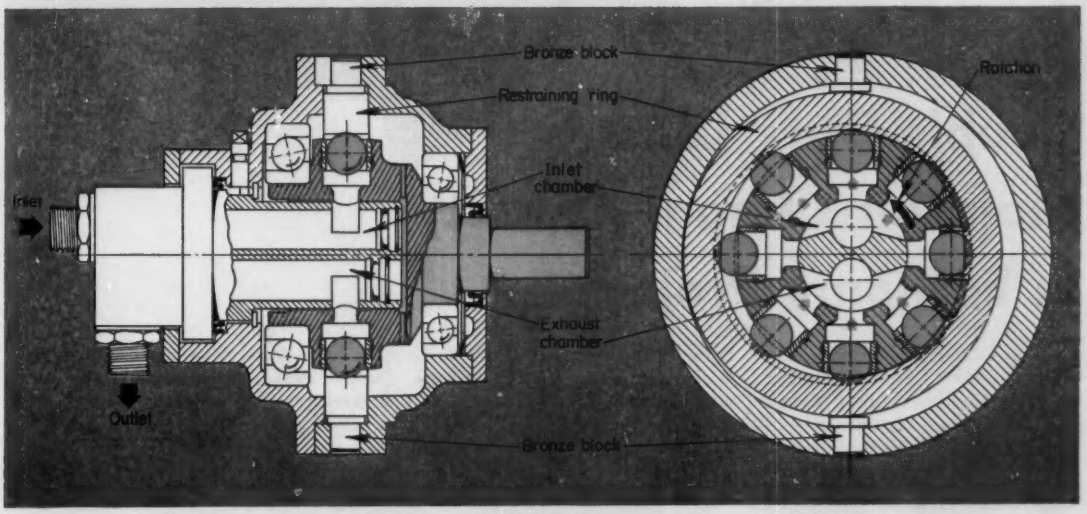
NUTS ON THE TWO SPINDLES are connected by a yoke which also supports a pin to operate the switching mechanism between the two spindles. Rotation of the actuating spindle in either direction moves the nut along the thread and closes a set of contacts to start the speed-shifting motor. Returning spindle, coupled to the speed-shifting motor, moves it's nut in the opposite direction to cancel the motion of the actuating nut and re-open the switch contacts.

MECHANICAL SERVO SWITCH was designed by PIV Antrieb Werner Reimers KG, Bad Homburg vdH, Germany.

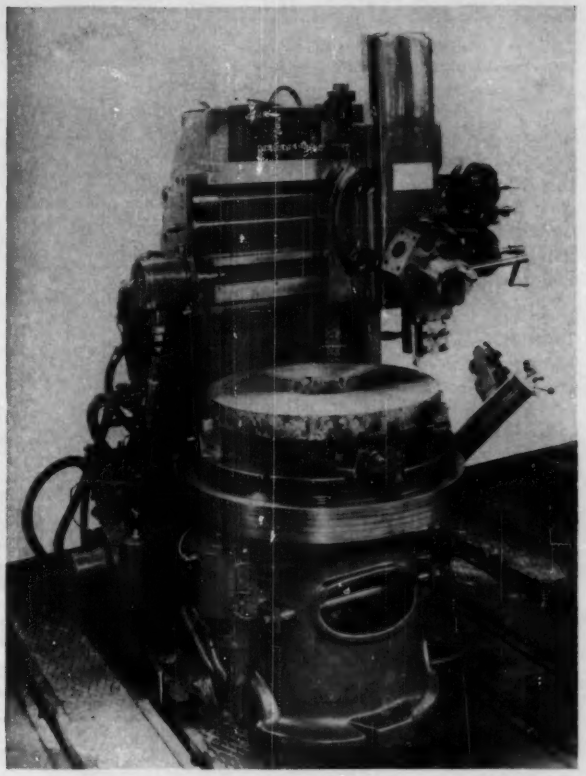


Ball-Piston Hydrostatic Transmission Provides Stepless Ratio Change

INFINITELY VARIABLE hydrostatic transmission uses radial thrust of ball-shaped, free-floating pistons to transmit energy between fluid and a revolving cylinder block. Cylinder linings, of a special material and specially heat treated, are claimed to have overcome the excessive wear problem that frustrated previous attempts to use ball-shaped pistons.



STROKE of balls is controlled by an eccentric restraining ring. It can be moved right or left by a suitable linkage (not shown) but is restrained from up and down motion by bronze blocks. Pintle valve is formed by two crescent-shaped chambers in a central shaft housing entrance and exhaust lines.



VERTICAL BORING MILL using the new hydrostatic transmission has no gear boxes or electronics. The transmission gives stepless control of cutting speed and feed. A linkage connected with the tool head controls the transmission rate to give the tool constant surface speed in spite of changing cutting radius. (See MD, May 25, 1961, page 122.) The transmission was developed by Mr. Donald Firth, engineer in Great Britain's National Engineering Laboratory, Kilbride, Scotland.

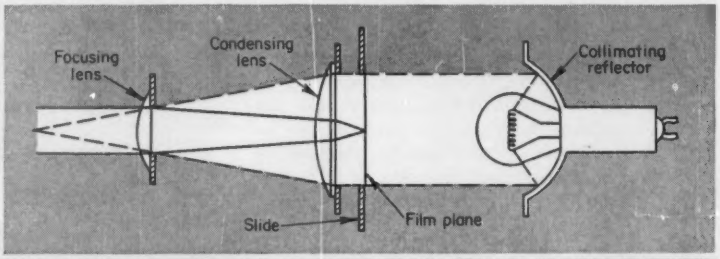
Double-Duty Lens Maintains Image Quality in Economy Projector

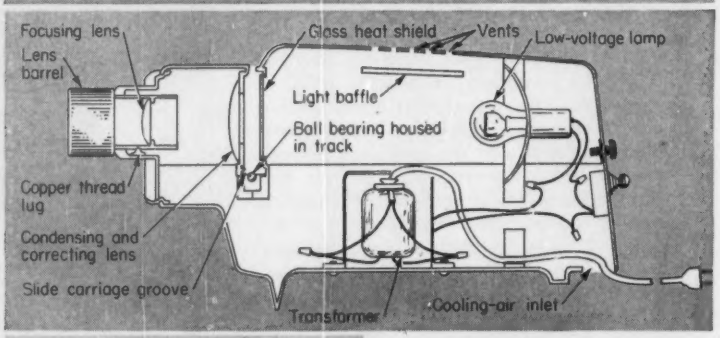
ECONOMY is an important consideration in the design of any giveaway product. The projector that Columbia Record Club gives to subscribers in the Panorama Colorslide Travel Program must meet a certain standard of quality and utility as well. Most of the working parts are of molded plastic. A transformer supplies low voltage to an automobile-type projection lamp. Quality is retained by reorganizing the optical system to let single-element condenser and focusing lenses work together to correct some chromatic aberration.

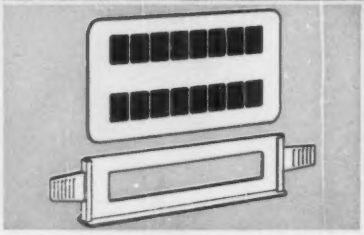
CONDENSER LENS has an unusual position just in front of the film. Here it does double duty:

- It converges the usable light from the film to exactly fit the aperture of the objective.
- It forms a second lens element to help minimize chromatic aberration. Ordinarily, a condenser lens converges the light from the lamp so it just covers the film. The designers call the condenser-focusing lens combination a modified Petzval Projection Objective.

TRANSFORMER provides 6-v current to operate the easily-replaced low-voltage lamp. Plastic lamp bracket snaps into molded-in grooves in the projector body. Integral parabolic reflector has metalized reflecting surface. Spring-loaded bearing ball improves travel of slide carriage in track.





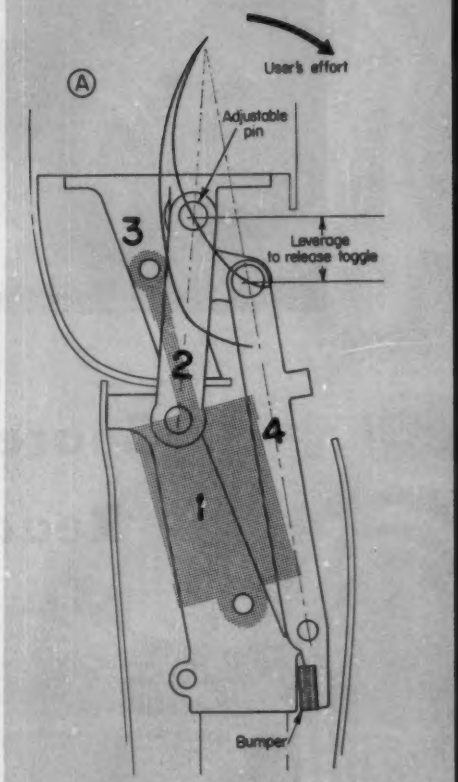


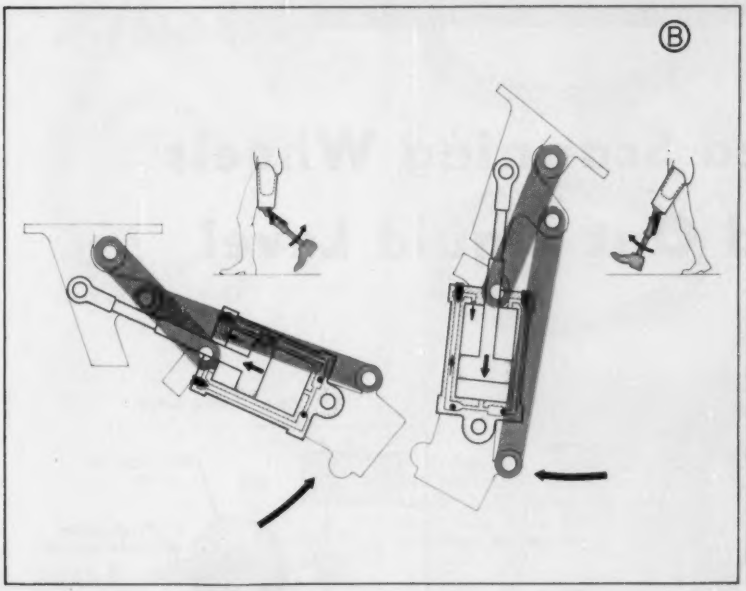
MULTIPLE-FRAME slides fit into the extra long slide carriage. Slides will hold sixteen frames ¾ by 1 in. (half of a standard 35-mm frame).

PANORAMA PROJECTOR was developed by Columbia and Lancaster Glass Corp., Lancaster, Ohio for use in the Panorama Colorslide Travel Program.

Polycentric Artificial Knee Simulates Natural Motion With 4-Bar Linkage

ARTIFICIAL knee-joint mechanism provides two necessary functions: Stable support during weight-bearing portion of walk cycle, and controlled swing-through during the remainder of the cycle. Over-center design of a four-bar linkage provides the stability needed, and action of the linkage follows closely the rolling motion of a natural knee joint. A pneumatic cylinder provides damping and energy storage. Mechanical advantage of the joint can be changed to suit the user's limitations by adjusting location of one of the pivots.

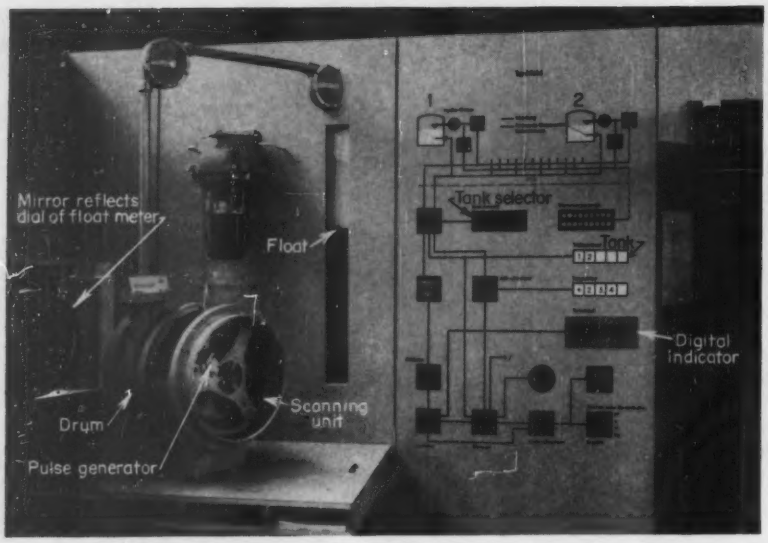




A **WALKER'S EFFORT** is transmitted through link 3. Higher than normal position of the pin between 2 and 3 gives more leverage to the walker as he drags the top of link 4 forward to start the bending motion.

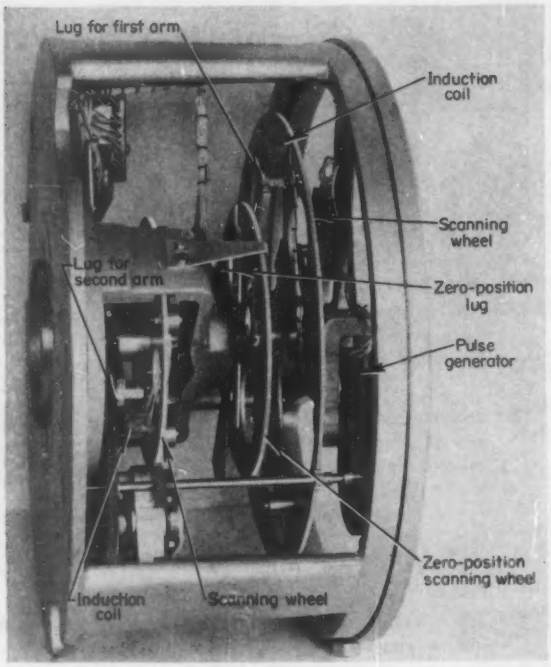
B **SHARPNESS OF SNAP** as the joint locks on the forward kick is limited by the damping effect of the pneumatic cylinder. It also limits lift of the heel on the back stroke. Air cylinder stores part of the energy for the return stroke. Needle valves for forward and backward motions can be individually adjusted to match the user's walking habits.

C **POLYCENTRIC** knee joint was designed at the Biomechanics Laboratory, University of California under the direction of Charles W. Radcliffe, Associate Professor of Mechanical Engineering. The research was supported by the Veterans Administration.

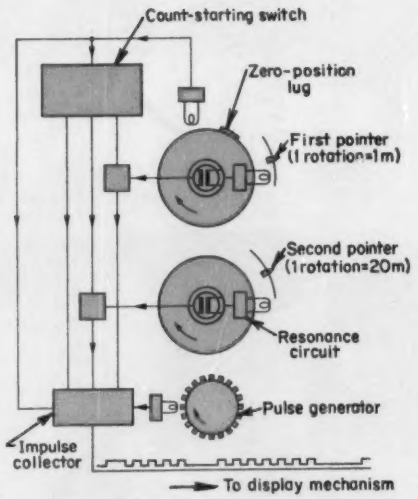


INDUCTION COILS mounted on geared scanning wheels are triggered by position lugs to revise digital readout of a liquid-level floatmeter once per revolution. The float is attached to a cable wound on a 1-m drum. The drum is coupled to arms supporting the lugs whose positions are electronically detected to give a precise, 5-digit readout of tank content. A dial with pointers coupled directly to the drum gives a continuous analog reading of liquid level.

Geared Scanning Wheels Read Out Liquid Level



COUNT OF PULSES in each detecting circuit is accumulated on the display mechanism until chain of pulses is cut off by canceling pulse from the scanning wheel for that circuit.



COARSE AND FINE position arms are detected by separate circuits. Pulse generator consists of a wheel with 20 lugs that produce pulses by passing through the field of an induction coil. Resulting pulses are timed to the rotation of the scanning wheels. Zero-position lug triggers a count cycle when both wheels are passing through "zero" or "empty" position.

The Problem: Product contamination from lubricants used in reciprocating sealing devices.

The Solution: Use a seal material capable of operating without lubrication.

Plastic Piston Rings

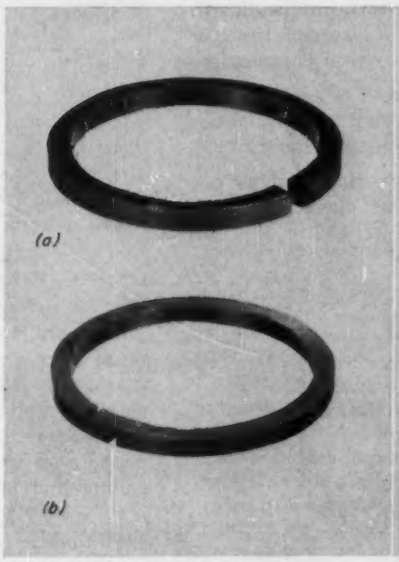


Fig. 1—Standard piston-ring configurations. Straight cut ring, *a*, is used where relatively high leakage is permissible; step-cut ring, *b*, is usually used where low leakage is required.

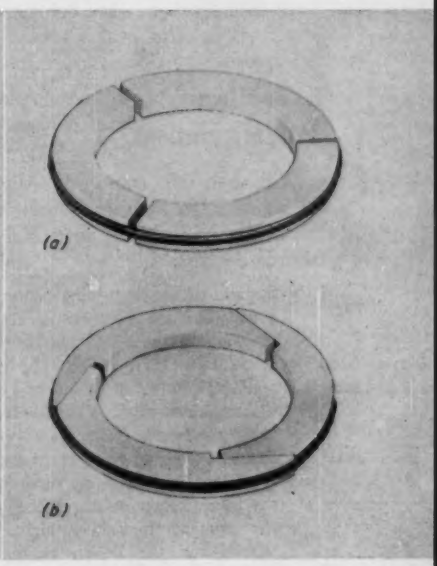


Fig. 2 — Multipiece rod packings. Segments may be cut radially, *a*, or tangentially, *b*.

ROSS D. PILLSBURY Jr.
Technical Representative
Polychemicals Dept.
E. I. du Pont de Nemours & Co. Inc.
Wilmington, Del.

CONVENTIONAL reciprocating equipment such as compressors require lubrication of piston rings for normal operation. But oil-to-product contact can cause major problems when requirements demand high purity of the material being moved. Certain chemicals react with the lubricants to form compounds detrimental to the machine, to the process, or to the effectiveness of the lubricants themselves. In pneumatic control systems, for example, small amounts of oil can clog orifices and valves. Oil, even in minute quantities, alters the taste of food and retards fermentation. And in an oxygen system, even a trace of oil is a fire hazard.

One solution to these problems is to install additional equipment to remove the oil after it has entered the system. A better solution, however, is to

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use a ring material capable of operation without lubrication.

A material that fulfills this requirement is Teflon TFE (tetrafluoroethylene) fluorocarbon resin. Beside not requiring lubrication, these Teflon materials also offer properties of low friction, chemical inertness, and a practical operating range of −450 to +500 F.

Fluorocarbon resins, compounded with glass, carbon, or metallic powders, are used in many reciprocating sealing applications. Piston rings up to 40 in. diam are available for use in compressors, pumps, and linear actuators (hydraulic or pneumatic). Molded segmental rings or braided packing (impregnated with fluorocarbons) are being used for rod sealing in compressors. Also, evaluations of TFE piston rings for internal-combustion engines have been encouraging.

Table 1—Modulus of Elasticity

Material	Young's Modulus, E (psi)
Steel	30×10^{-6}
Cast iron	10 to 18×10^{-6}
Carbon	1.5 to 3×10^{-6}
Filled fluorocarbons (Teflon)	0.4×10^{-6}
Rubber (90 Durometer)	0.001×10^{-6}

Configurations

Although all standard sealing-ring designs can be made with fluorocarbon resins, operating experience has proved the particular reliability of a few simple designs:

- Straight-cut or butt-joint piston rings, Fig. 1*a*, leave a gap, and are adequate as expanding rings for piston sealing where slight leakage is permissible.
- Step-cut piston rings, Fig. 1*b*, have positive joints for sealing in either direction, and are usually used with flat expander rings. Leakage is much less than with straight-cut seals.
- Segmented piston rings are a standard design for stiff, brittle materials that are more difficult to install than the fluorocarbon resins. When made of a TFE resin, the segments may be straight, step-cut, or specially shaped for the design or operating requirements. Spring expanders are generally used with segmented rings.
- Solid rings minimize gas leakage. They are used in small hydraulic and pneumatic components. Rings usually are made oversize to assure radial sealing and are backed with O-rings to minimize fluid bypass.
- Segmented rod packings can have tangential or radial cuts, Fig. 2. Sections are usually confined in cup housings. Garter springs hold the ring segments together for assembly. Combinations of several packing shapes may be used, the number of sets depending upon the pressure differential.

Material Properties

Sealing: For effective dynamic and static sealing, both radial and axial fluid forces must be large enough so that the ring seals against the cylinder wall and the downstream side of the ring groove. Normally, fluorocarbon sealing rings are provided with metal springs (inner rings of cast iron, bronze, or stainless steel) to insure initial seating and low-pressure radial sealing.

Friction: The fluid forces must be able to move the mass of the ring fast enough (as the piston changes direction) to provide an effective seal. The low coefficient of friction of TFE materials provides the rapid ring response necessary for uniform output of the equipment. The static coefficient of friction for the filled compositions of fluorocarbons (unlubricated) normally used for dynamic seals ranges between 0.070 and 0.148 against cast iron and steel. In contrast, the coefficient values of lubricated cast iron in identical applications are 0.123 to 0.300.

At high loads and slow velocities, fluorocarbon resins offer lower coefficient of friction values (approximately 0.04) than any other solid material including graphite and molybdenum disulfide. Friction for these resin materials decreases with increased pressure—a vital factor in eliminating seizing and galling and promoting smooth ring movement.

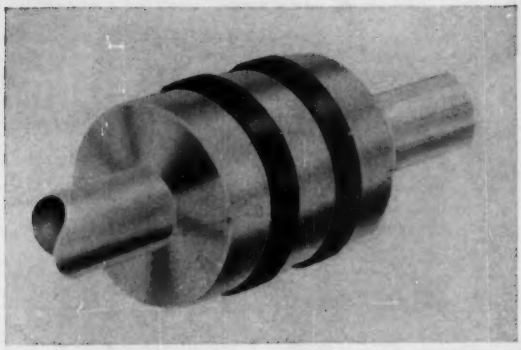
Flexibility: The resilience and nonbrittleness of fluorocarbon materials facilitates simple installation of split rings over the piston head—even with small-diameter pistons. Solid rings also can be installed by expanding and slipping the ring over the piston.

Conformability: Because effective sealing depends on even contact pressure between mating surfaces of an assembly, conformability of seals is a function of Young's modulus. Metallic seals cannot conform as well as elastomers to substantial out-of-roundness, angularity, or waviness, and fluorocarbon seals have a modulus between the two groups, Table 1.

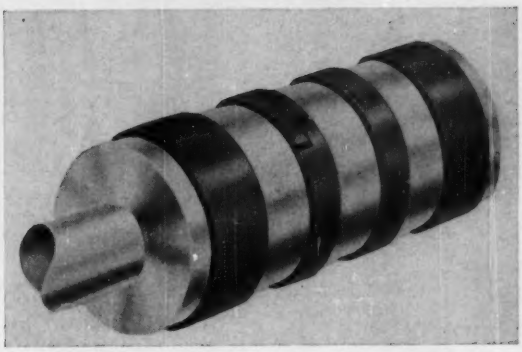
Fluorocarbon resins maintain effective seals despite wear. Compressor manufacturers and equipment operators report low blow-by with fluorocarbon piston rings.

Axial conformability is largely determined by the squareness and finish of the groove walls. A groove wall that is out of square will cause twisting of any ring, with a subsequent reduction in sealability.

Rings of all materials undergo an initial seating or wear-in procedure. During this operation, TFE rings coat mating surfaces with fine particles of resin, thus providing low-friction, resin-on-resin contact. For optimum performance, recommended cylinder-wall finish is 12 to 30 mu in. A 12 mu in. finish is sufficient for resin transfer and 30 mu in. is about the maximum to prevent excessive wear.



(a)



(b)

Fig. 3—Piston-support devices. Especially for non-vertical applications, pistons must be positioned and supported to eliminate metal-to-metal contact. Common support devices are, *a*, tail rod, and *b*, one or two rider rings (at piston ends).

Corrosion Resistance: Ring seals of fluorocarbon resins can operate in a variety of environments, ranging from liquefied gases at −320 F, to corrosive gases at 500 F. These chemically inert resins are affected only by metallic sodium and certain halogenated compounds at elevated temperatures and pressures. Piston rings of TFE resins have excellent life in air, oxygen, nitrogen, hydrogen, helium, ammonia, hydrocarbons, and various chemical-plant gases. Because many inorganic fillers are adaptable to the resins, fillers can be selected to meet almost any corrosive condition.

Wear-Resistance: Filled compositions of fluorocarbon resins exhibit longer life—sometimes 350 times longer—in rubbing service than unfilled resins.

Wear rate depends on pressure, velocity, sliding distance, lubrication, cylinder finish, temperature, and ring and cylinder materials. Wear of fluorocarbon piston rings with cast iron or stainless-steel cylinders is not excessive. Chromium-plated cylinders are recommended, however, over plain cast iron for corrosive service and for protection against rusting which might occur during shutdown periods. Generally, wear rate is significantly reduced by the harder metal bearing surfaces (R_C 55 or higher). Although wear against aluminum is relatively high for filled fluoropolymers, these resins are among the few materials giving good wear life under these conditions.

Because TFE resins are not abrasive, cylinder wear is low and scoring is almost completely eliminated. Although the resins can embed and apparently cover up hard dirt particles to minimize wear on the piston ring or cylinder, there is, of course, a limit to embedability. A system which permits rust or hard process scale to enter the cylinder can be expected to have short ring life and high cylinder wear. Properly maintained intake filters and corrosion-resistant piping can extend equipment life in such systems.

Piston Design

Compressors and similar equipment vary in design; cylinders may be horizontal, vertical, or in a "V" position. To prevent metal-to-metal contact between piston and cylinder, the piston can be supported by a tail rod, Fig. 3*a*, or by one or more rider or wear rings, Fig. 3*b*. The piston must be positioned and supported so that its contact with the cylinder is eliminated and the rings can function properly. Misalignment can cause poor sealing and cylinder-wall scoring.

Rider rings are usually of the same composition as sealer rings, but they should be wider than the sealer rings so that the unit load is below about 5 psi (based on rider ring projected area). The weight carried by rider rings in a horizontal cylinder is considered as the weight of the piston plus one-half the weight of the rod. Aluminum or cored cast-iron pistons are used to minimize weight and permit reasonable widths of rider rings.

Radial thickness of rider rings is selected to provide sufficient running clearance between rings and cylinder at operating temperatures. Although split rider rings are normally used, solid riders are often preferred in equipment where the rings pass over valve ports or out over counterbores.

Sealing rings of fluorocarbon resins are usually wider than metal rings. Side-wall clearance and ring end gap must be adequate to allow for thermal expansion of the resin. The expansion rate in the axial direction (direction of molding) may be as much as three times the radial expansion rate. Binding, caused by inadequate groove width, can prevent proper sealing and can cause rapid wear. In most cases, piston designs must be modified to convert from metal to TFE piston rings.

They Say . . .

"The great inventions which shine as mileposts in man's history were all meant to do a job faster and with less effort. Gutenberg's printing press is a good example, and note that this invention replaced thousands of people who earned their living by painstakingly writing books by hand. But note also that the greatly increased production of books allowed a much greater rate of dissemination of ideas and knowledge, opening the door to the glories of the Renaissance. Thus it is that the machines have brought about twofold results: replaced hard, tedious labour and benefited mankind by producing more for the enjoyment of all."—RENE SIMARD, *Engineering Div., Imperial Oil Ltd., Sarnia, Ont., Canada.*

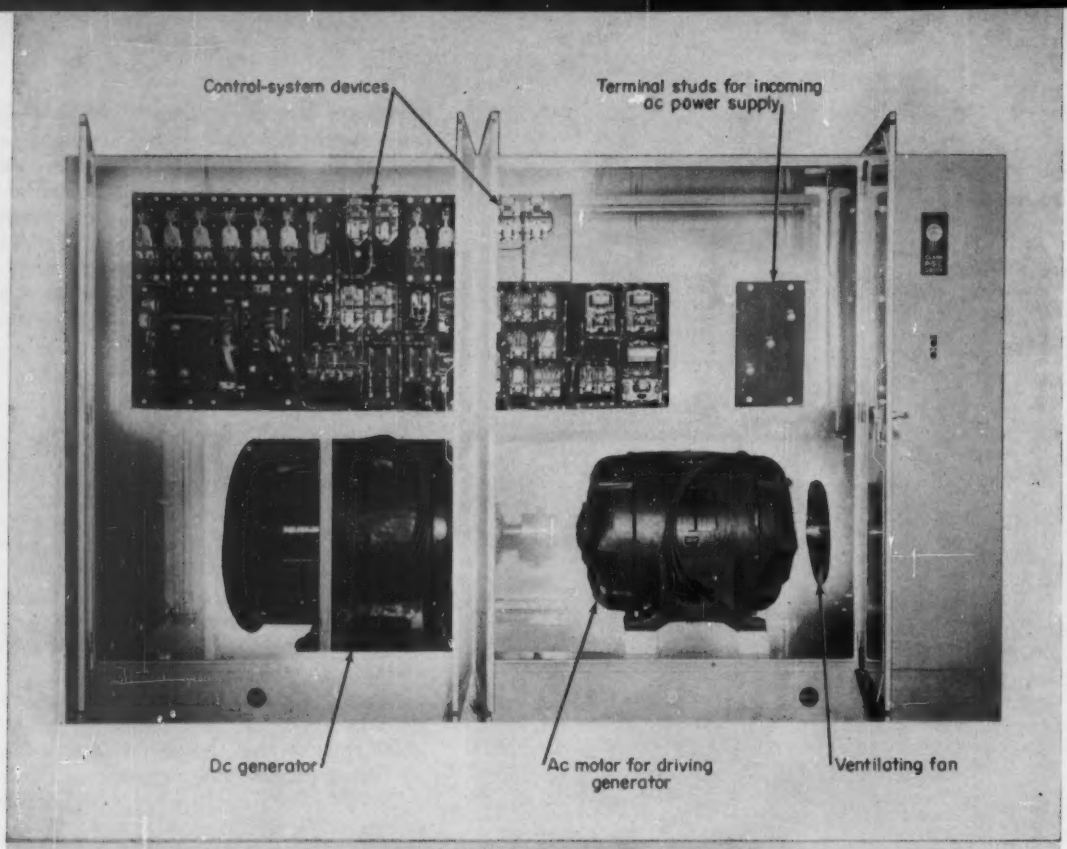


Fig. 1—Packaged drive which uses a dc generator to provide output power. This particular adjustable-voltage control unit supplies and controls a 150-hp, 230-v dc motor.

DC Motor Control

J. RONALD WICKEY
Staff Engineer
The Clark Controller Co.
Cleveland, Ohio

INDUSTRIAL drives for machines and processes often require a certain accuracy, tension, speed range, speed synchronization, or flexibility to achieve the desired end result. In many cases these demands on the control system can be accomplished only by the use of dc adjustable-voltage control.

While adjustable-voltage control sometimes seems complicated and difficult to understand, the basic concept is comparatively simple. Even a complete system which includes several drives is usually relatively simple when each drive is considered individually. Some sophisticated control systems, however, are necessarily complex to accomplish the required functions, but the basic principles are the same.

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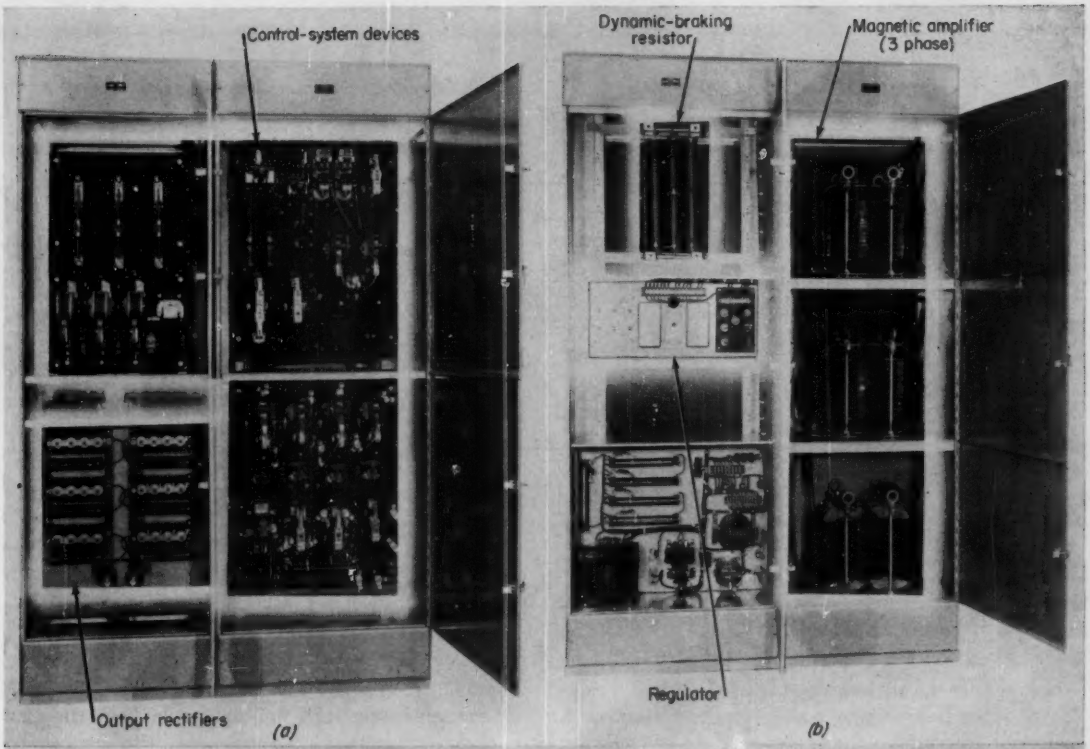


Fig. 2—Front, *a*, and rear, *b*, of a packaged drive which uses a magnetic amplifier and silicon rectifier to provide output power. A silicon controlled rectifier unit would have a similar appearance. The unit shown supplies and controls an 80 hp, 230-v dc motor on a wire drawing application.

Part 6 — Adjustable-Voltage Control

. . . an accurate and fundamentally simple system for obtaining a wide range of motor speeds

This article on adjustable-voltage control concludes the series* on dc motor control. However, because the subject is very broad, little more than the basic concepts can be presented here.

Principle of Operation

The speed of a dc motor, while its field excitation remains constant, is essentially proportional to the voltage applied to the motor armature. If the voltage applied to the motor armature is varied, the resultant speed of the motor, in turn, will be varied or adjusted. A control system based on this method of operation is an adjustable-voltage control system.

Adjustable-voltage systems are often known by other names. Originally, years ago, they were usually known as Ward Leonard systems because a Mr. Ward Leonard was the first to recognize, or at least to apply, this method of obtaining speed adjustment. Later, and until recently, the more commonly used expression was variable-voltage control systems. Because the voltage level, after it was selected, did not vary, the voltage was not truly "variable."

The term that is accepted in modern nomenclature is adjustable-voltage control systems since this expression is more properly descriptive. However, at least to some extent, these three expressions are used synonymously and usually have the same meaning

*See References at end of article.

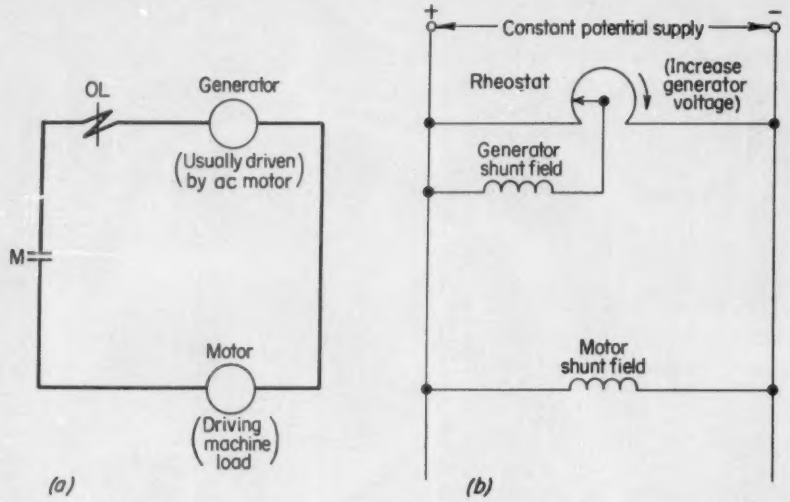


Fig. 3—Basic elements of an adjustable-voltage system. Power circuit is shown in *a*; field circuit, in *b*. The control circuit is not included.

when applied to an industrial control system.

An adjustable-voltage control system requires a source of adjustable-voltage dc power. In general, the most convenient source of such power is a dc generator, usually the shunt-wound type. Other sources are electronic or other types of rectifier devices. In one combination often used, the output of a magnetic amplifier is fed through dry-type rectifiers to provide a controlled dc power supply. Advances in the technology of silicon controlled rectifiers indicate appreciable use of these devices in the near future for such application.

It is sometimes practical to combine the dc adjustable-voltage power source and the associated control into one physical assembly often referred to as a packaged drive. These units are especially useful where only one dc motor must be supplied, Fig. 1, 2.

The basic philosophy of adjustable-voltage systems is probably best expressed and understood on the basis of a generator being considered as the source of dc power. Hence, this discussion is limited to that type of equipment.

System Advantages

The many advantages of an adjustable-voltage control system account for its widespread use in industrial applications. Probably the most basic and important advantage is the amount of speed reduction that can be obtained below base speed of the motor being controlled.

This system provides good operation over a speed range of approximately 10 to 1; that is, from base speed of the motor to approximately 10 per cent of base speed. While it is sometimes possible to obtain even lower speeds, mechanical and electrical losses tend to become a larger factor, and an unstable condition may be reached. Thus, approximately 10 per cent of base speed is usually considered the minimum running condition. The wide speed range is obtained merely by changing the field excitation of the generator with an adjustable field rheostat.

If an adjustable-speed motor is used, the total range of the system can be easily expanded. For example, if a motor has a 4 to 1 speed range, the total speed range of the system can be 10 times 4, or 40 to 1.

An adjustable-voltage control system requires only a minimum of power-circuit type equipment, such as contactors and power-circuit resistors. This can be a big advantage, especially where the motors involved have high ratings.

Operating characteristics of an adjustable-voltage control system are good, and the available speed control is accurate. Any speed selected will remain within reasonably close limits, or can be reobtained accurately, even though the load requirements of the connected machinery vary.

An adjustable-voltage control system involves a simple basic concept and requires only a minimum of equipment. For the power circuit, the armatures of the generator and motor are connected in series to form a closed loop. The motor shunt field is connected across a constant - potential supply. The generator shunt field is also connected across this same supply, but with a rheostat to provide adjustment. Adjusting the generator field in turn adjusts the output voltage of the generator and thus provides adjustable voltage to, and adjustable speed of, the controlled motor. While the rheostat can be in series with the generator shunt field, a potentiometer-type circuit is normally used because it is more flexible.

The basic elements of an adjustable-voltage system, Fig. 3, are a main contactor, M, and an overload relay, OL, which are usually supplied to provide necessary protection. Also included is the field rheostat, which can be either hand operated or motor operated. Because it can be used for either re-

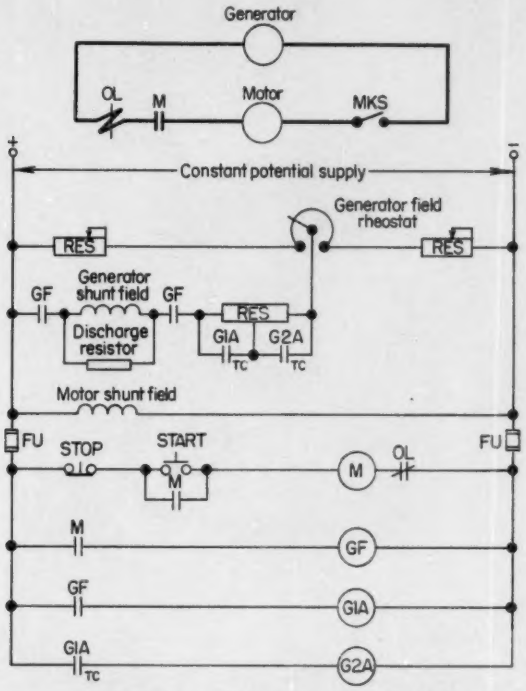


Fig. 4—Adjustable-voltage system with acceleration controlled by generator field relays. Running speed is set by position of hand-operated rheostat.

mote or automatic control, the motor-operated type is extensively used.

A variation of the hand-operated rheostat consists of the addition of a generator-field resistor and two or more field accelerating relays, Fig. 4. With this arrangement the rheostat can be left in any desired speed position when the control system is shut down. Then, when the system is started, the resistor and relay combination will "accelerate" the generator field to the preset condition. Note that relays are used for this operation because only small values of field current are handled. Large power-circuit accelerating contactors are not required.

Reversing the direction of operation is accomplished by reversing the polarity of the generator. This, in turn, can be done easily by reversing the polarity of the generator field. A set of reversing relays can be used for this purpose. Here again, only relays are required, not power-circuit contactors.

When the *start* button in Fig. 4 is pressed, main contactor M closes, which then closes generator-field relay GF to energize the generator field. However, there is enough resistance in series with this field to limit generator voltage to a low value. The series resistance is shorted out in timed steps by field accelerating relays G1A and G2A, thus bringing generator voltage to the value determined by the setting of the field rheostat. This simple method of acceleration is satisfactory for many applications.

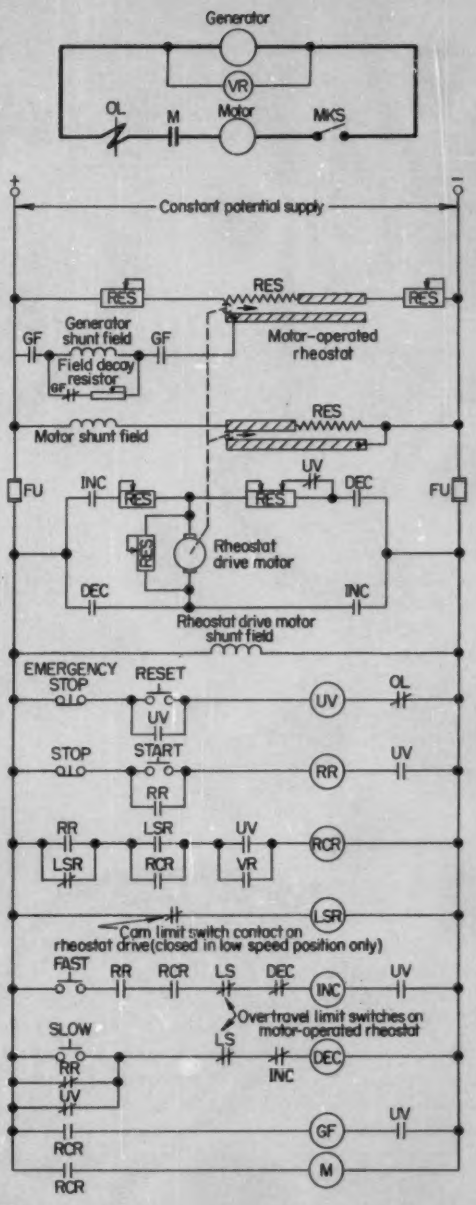


Fig. 5—Adjustable-voltage system with generator field controlled by motor-operated rheostat. Motor field control is also included. Running speed is determined by travel of rheostat.

Because high armature currents can result if the field rheostat is manipulated rapidly to increase generator voltage to the desired value, the rheostat is often motor operated. The adjustable-voltage control system in Fig. 5 incorporates this feature. The motor-operated rheostat controls not only the generator field excitation but also the field excitation of the motor. This method of control provides a wide

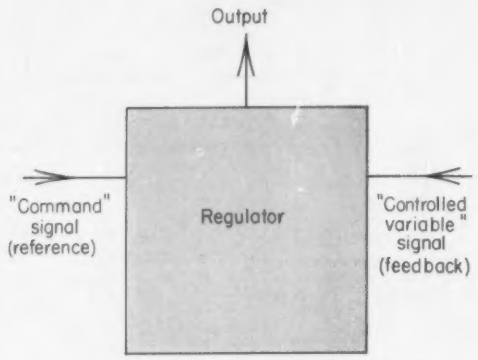


Fig. 6—Basic concept of a regulator.

speed range as well as smooth acceleration and deceleration of the motor at a rate determined by the adjustable travel speed of the motor-operated rheostat.

The schematic diagram of Fig. 5 includes other operational features such as: 1. Automatic and controlled deceleration time when the *stop* button is pressed. 2. Automatic and rapid stop by regenerative braking, provided by rapid decay of the generator field through a resistor, when the *emergency stop* button is pressed. 3. Interlocking to prevent starting unless the motor-operated rheostat is in the *low* speed position.

Types of Regulators

Adjustable-voltage control methods of the types illustrated in Fig. 4 and 5 are widely used because they provide excellent control and operation characteristics and require only a moderate amount of control equipment and devices. However, in complex modern industrial applications, such as processing lines where several motors must be co-ordinated with each other, a common practice is to use a regulator to supply and regulate the generator field current. Such a device gives "automatic" operation in addition to faster and more accurate results than could be obtained by any manually controlled method.

Basically, a regulator is a device which compares a command signal (reference) with a controlled variable signal (feedback). Any difference in these two signals causes the regulator output to change. Correspondingly, the controlled equipment changes its operation until the feedback signal is in balance with the reference signal. This basic concept is shown in Fig. 6.

Physically, regulators may be rotating, electronic, static, or a combination of these three types. A combination often used is a magnetic-amplifier which controls the output of a silicon controlled rectifier, Fig. 7.

Functionally, regulators may be broadly classified as current, speed, and voltage regulators. The reference signal may be originated by the operator, usually by means of a small control rheostat, or may be obtained from an appropriate signal from another drive in the same co-ordinated system.

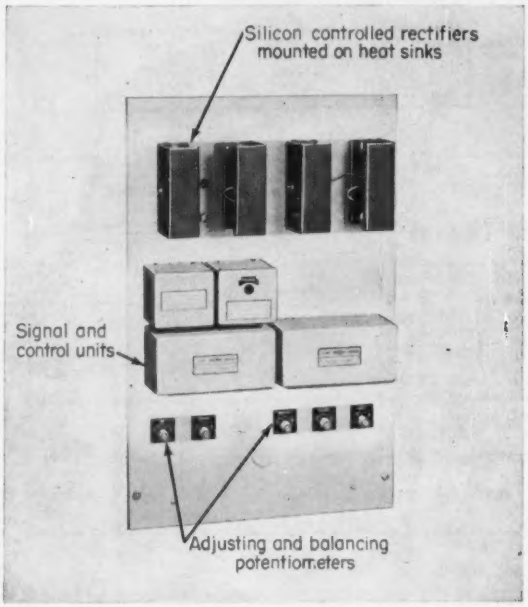

Silicon controlled rectifiers mounted on heat sinks
Signal and control units
Adjusting and balancing potentiometers

Fig. 7—Silicon controlled rectifier type of regulator. Control is provided through gate switching by a magnetic amplifier. All components are solid-state devices. Modular-type signal and control units provide flexibility and ease of replacement or modification.

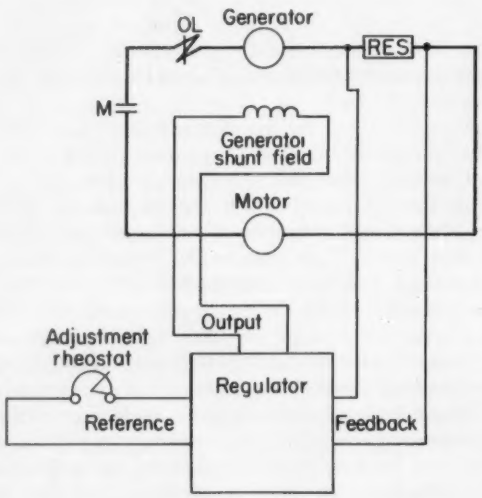


Fig. 8—Diagram of current-regulator control system.

A current regulator, Fig. 8, usually is applied as a tension-regulating device for a web or strip of material between two machines. A typical application is a winding process where tension must be controlled and maintained within preset limits in the material

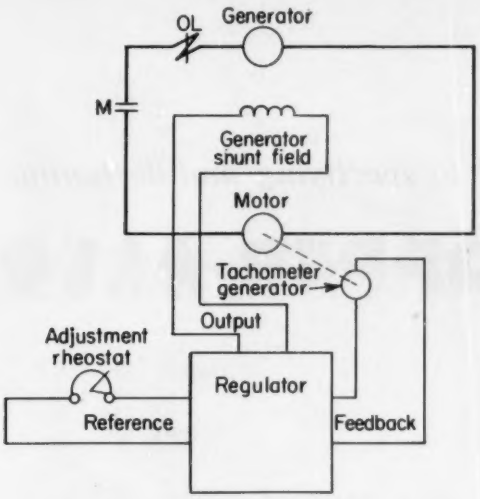


Fig. 9—Diagram of speed-regulator control system.

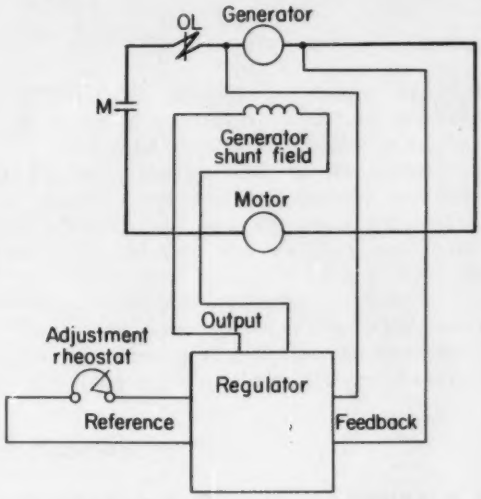


Fig. 10—Diagram of voltage-regulator control system.

as it is being wound on a center-wind reel.

A speed regulator, Fig. 9, maintains the same speed for various machines in a co-ordinated system, especially where a material in process needs to be kept reasonably taut but cannot be subjected to appreciable tension. A speed regulator can also be used to maintain a desired speed relationship between associated drives, such as a multiunit conveyor where each section must run slightly faster than the preceding section.

A voltage regulator, Fig. 10, is somewhat limited in its application to industrial drives since the voltage in a system is not an exact measure of speed and has little relationship to tension. However, this type of regulator is useful where exact speed regulation is not important or where a proper speed reference or feedback signal is too difficult to obtain. It is, of course, ideally suited to any nonmotorized application where maintenance of a desired voltage is important.

Although regulators are not a basic necessity for the functioning of an adjustable-voltage control system, they are useful tools which are finding increased application.

REFERENCES

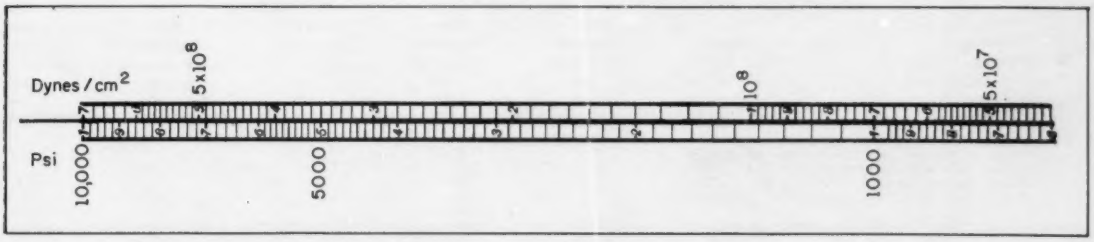
This article is the sixth and concluding part in a series by J. Ronald Wickey on dc motor control. Previous articles and the issues of MACHINE DESIGN in which they appeared are:

1. Motor Types and Characteristics ..... July 20, 1961
2. Circuit Functions of Control Devices ..... August 3, 1961
3. Basic Controller Hardware ..... August 17, 1961
4. Accessory Devices and Controller Construction ..... August 31, 1961
5. Conventional Controllers and Their Application ..... September 14, 1961

Tips and Techniques

Conversion Scales

Strips cut from log paper are useful in making conversions from one system of units to another. The illustration shows a scale for converting dynes/cm² to psi from the relationship 10^8 dynes/cm² = 1450 psi. Such scales can be made for many other proportional relationships between units.—ERIC E. UNGAR, *Newton Center, Mass.*



A guide to specifying and designing . . .

COPPER-ALLOY

J. P. LYNCH
Project Metallurgist

C. F. DeVARNEY
Divisional Foreman, Rod Mill

C. J. CONNORS
Superintendent, Rod Mill

Ansonia Div., Anaconda American Brass Co., Ansonia, Conn.

Table 1—Composition and Typical Properties of Group A Alloys

	Architectural Bronze	Free-Cutting Muntz	Free-Cutting Muntz	Muntz Metal	Forging Brass	Free-Cutting Brass
ASTM Spec	....	....	....	....	B124	B16
CABRA* Data Sheet	24	....	....	12	23	20
Composition, Nominal (per cent)						
Cu	56.0	58.0	58.0	60.0	60.0	61.5
Zn	41.5	38.75	40.0	40.0	38.0	35.25
Pb	2.5	3.25	2.0	....	2.0	3.25
Sn	....	....	....	....	....	....
Mn	....	....	....	....	....	....
Fe	....	....	....	....	....	....
Physical Properties						
Density (lb/cu in.)	0.305	0.306	0.304	0.303	0.305	0.307
Melting Temp (F)	1610	1630	1620 (est)	1650	1620	1630
Coefficient of Thermal Expansion, 77 to 572 F (per deg F)	11.6×10^{-6}	11.6×10^{-6}	11.6×10^{-6}	11.6×10^{-6}	11.5×10^{-6}	11.4×10^{-6}
Electrical Conductivity (per cent IACS)	28	28	28 (est)	28.4	27	26
Thermal Conductivity at 68 F (Btu/hr/sq ft/ft/deg F)	71	71	70 (est)	72	69	67
Mechanical Properties						
Tensile Strength, (1000 psi)	60	60	60	54	54	47
Yield Strength†, (1000 psi)	20	20	25	20	20	18
Elongation in 2 in. (%)	25	25	25	45	45	55
Hardness, Rockwell	B65	B60	B55	B45	B45	B20
Fabricating Properties						
Cold Workability	Poor	Fair	Fair	Fair	Fair	Poor
Hot Workability	Excellent	Excellent	Excellent	Excellent	Excellent	Good
Hot Working Temp (F)	1150 to 1350	1150 to 1450	1150 to 1450	1150 to 1450	1200 to 1500	1300 to 1450
Machinability Rating§	80	90	80	40	50	100
Intricacy Index‡	100	95	95	85	95	90

*Copper and Brass Research Association.
†Value at 0.5 per cent extension under load.
§Based on free-cutting brass = 100.
‡Based on architectural bronze = 100.

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EXTRUSIONS

- Materials
- Design
- Tolerances

THE family of copper-base alloys offers a wide range of engineering properties and fabrication characteristics in extruded parts. Among the desirable characteristics of the various alloys are: Excellent electrical and thermal conductivity, high corrosion and wear resistance, good ductility, high yield strength, and excellent machinability. Perhaps even more important, most of these alloys can be extruded into highly intricate shapes.

This article discusses material selection, lists engineering properties, and presents recommendations for designing extruded parts of copper-base alloys.

Materials

The commonly extruded copper-base alloys are divided here into three categories:

Group A: Architectural bronze, brasses, and manganese bronze

Group B: Coppers

Group C: Nickel silvers and aluminum-silicon bronze

The greatest volume of extruded shapes produced in these materials is made from Group A alloys, Fig. 1. Composition and properties of the prominent alloys in this group are given in Table 1. Similar data for alloys in Group B and C appear in Tables 2 and 3.

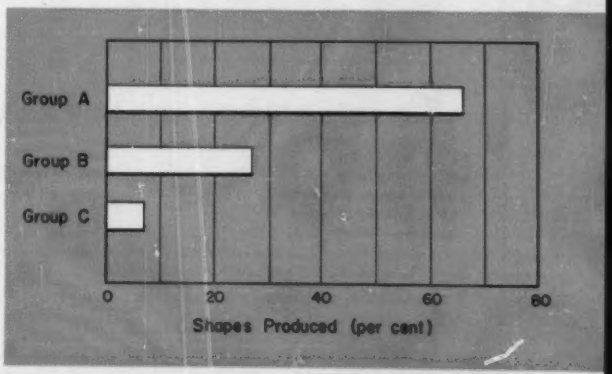
Group A alloys resist scuffing and atmospheric corrosion. Shapes are usually furnished in the as-extruded condition, but they can also be subsequently drawn to obtain closer tolerances and higher mechanical properties.

Extrusions made from Group B alloys—the coppers—are available in either the soft or drawn (about 15 per cent) tempers. These alloys offer high thermal and electrical conductivity.

Group C alloys, supplied only in the as-extruded

	Naval Brass	Leaded Naval Brass	Manganese Bronze
	B21-A, B124	B21-C	B124, B138
	26	27	28
	60.0	60.0	58.5
	39.25	37.5	39.25
		1.75	....
	0.75	0.75	1.0
	....	....	0.25
	....	....	1.0
	0.304	0.305	0.302
	1630	1630	1590
	11.8×10^{-6}	11.8×10^{-6}	11.9×10^{-6}
	26	26	23
	67	67	59
	56	56	65
	25	25	30
	40	35	30
	B50	B50	B65
	Fair	Poor	Poor
	Excellent	Excellent	Excellent
	1200 to 1450	1200 to 1400	1150 to 1450
	30	80	30
	85	85	80

Fig. 1—Percentage of various copper-base alloy groups used in extrusions.



condition, offer high strengths and excellent corrosion and heat-resistance properties.

Intricacy: An intricacy index has been assigned to each of the copper-base extrusion alloys, Tables 1, 2, and 3, to serve as a guide to the selection of the most suitable alloys for extruded parts. The index is based on a rating of 100 for architectural bronze. Ratings of 85 or higher (most Group A alloys) indicate that extremely intricate shapes are feasible. Ratings in the range of 65 to 75 (Group B alloys) indicate that shapes can be moderately intricate. Alloys with intricacy ratings of 60 or lower are not recommended for shapes with fine detail.

Intricate parts with nonuniform sections are common production items in the brasses, Fig. 2*a*, and the coppers, Fig. 2*b*. Some copper alloys, such as aluminum-silicon bronze and nickel silver, are more difficult to extrude than the brasses, bronzes, and coppers. With these materials, extrusions are limited to relatively simple shapes of nearly uniform thick-

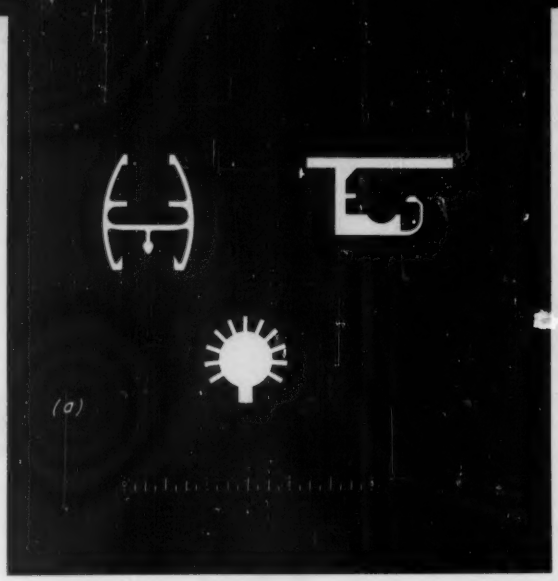


Fig. 2—Typical extrusion shapes in copper-base alloys. The brasses, *a*, can be used for more intricate shapes than the coppers, *b*.

Table 2—Composition and Typical Properties of Group B Alloys

	Electrolytic Tough Pitch Copper	Oxygen-Free Copper	Tellurium Copper (Free machining)
ASTM Spec	B-124 B-133 B-187	B-124 B-133 B-187	.....
CABRA Data Sheet	2	4	.....
Composition, Nominal (per cent)	Cu 99.90 (min) O 0.04	Cu 99.90 (min)	Cu 99.49 Te 0.50 P .01
Physical Properties			
Density (lb/cu in.)	0.322	0.323	0.323
Melting Temp (F)	1981	1981	1922
Coefficient of Thermal Expansion, 77 to 572 F (per deg F)	9.8×10^{-6}	9.8×10^{-6}	9.8×10^{-6}
Electrical Conductivity (per cent IACS)	101	101	95
Thermal Conductivity at 68 F (Btu/hr/sq ft/ft/deg F)	226	226	215
Mechanical Properties			
Tensile Strength (1000 psi)			
Soft	32	32	32
Drawn (approx 15%)	40	40	40
Yield Strength* (1000 psi)			
Soft	10	10	10
Drawn	32	32	32
Elongation in 2 in. (%)			
Soft	50	50	45
Drawn	30	30	25
Hardness, Rockwell			
Soft	F 45	F 45	F 45
Drawn	F 77	F 77	F 77
Fabricating Properties			
Cold Workability	Excellent	Excellent	Good
Hot Workability	Excellent	Excellent	Good
Hot Working Temp (F)	1400 to 1600	1400 to 1600	1400 to 1550
Machinability Rating†	20	20	80
Intricacy Index‡	75	75	65

*Value at 0.5 per cent extension under load.
†Based on free-cutting brass = 100.
‡Based on architectural bronze = 100.

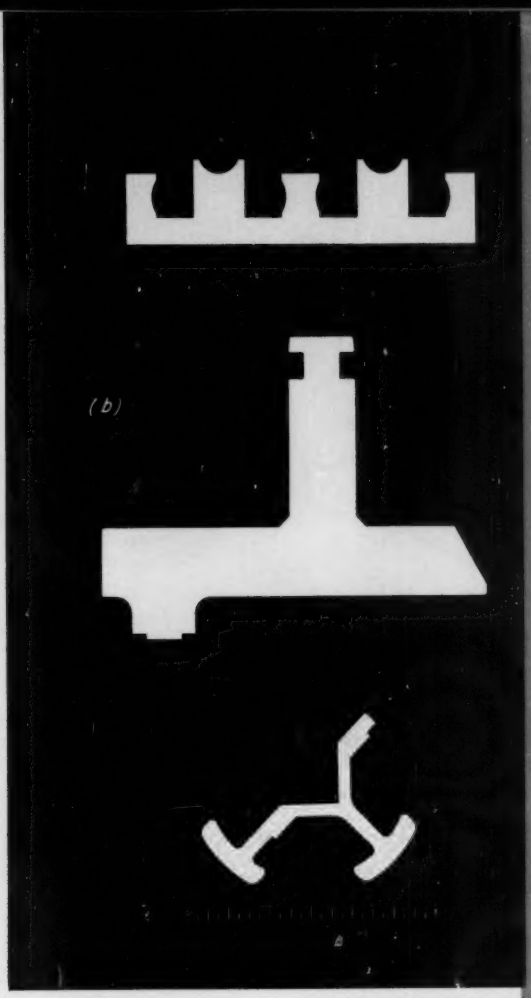


Fig. 3—Typical extruded shapes in aluminum-silicon bronze and nickel silver. These alloys, being more difficult to extrude than the brasses, bronzes, and coppers, are limited to relatively simple shapes.

Primary Alloy Characteristics and Typical Applications of Copper-Base Extrusions

Alloy	Characteristics	Applications
	Group A: Brasses, Bronzes	
Architectural Bronze	Most intricate shapes possible. Excellent machinability. Not suitable for bending or cold working.	Architectural shapes, forgings, hinges, lock bodies.
Free-Cutting Muntz (58 Cu, 38.75 Zn, 3.25 Pb)	Excellent machinability. No restrictions on shapes. Slight bending.	Mechanical and hardware components requiring extensive machining.
Free-Cutting Muntz (58 Cu, 40 Zn, 2 Pb)	Best compromise of cold-forming characteristics, machinability, and intricacy rating.	Mechanical components requiring both cold forming and machining.
Muntz Metal	Usually preferable to leaded alloys for welding. Moderate bending. No restrictions on shapes. Fair machinability.	Miscellaneous hardware and forgings, trim components.
Forging Brass	Best alloy for forging. Good hardness and machinability. No restrictions on shapes. Moderate bending.	Miscellaneous forgings and pressings.
Free-Cutting Brass	Excellent machinability. Suitable for slight bending or cold working. No restrictions on shapes.	Gears, pinions, parts machined at high speeds, roll-threaded and knurled parts.
Naval Brass	Good resistance to salt-water corrosion. No restrictions on shapes. Moderate bending.	Marine hardware, structural components, aircraft turnbuckle barrels.
Leaded Naval Brass	Good resistance to salt-water corrosion. No restrictions on shapes. Good machinability. Slight bending.	Marine hardware and forgings requiring machining.
Manganese Bronze	Excellent wear resistance. High strength and good corrosion resistance. Suitable for slight bending, relatively simple shapes.	Miscellaneous hardware and automotive parts, forgings, hot-upset and hot-headed parts.
	Group B: Coppers	
Electrolytic Tough Pitch Copper	Excellent electrical and thermal conductivity. Relatively simple shapes.	Switch gear, electrical hardware and contacts, heat dissipators, bus bars, cold-headed parts.
Oxygen-Free Copper	Excellent electrical and thermal conductivity. Relatively simple shapes. Used where parts are to be brazed in reducing atmosphere.	Same as electrolytic tough pitch copper.
Tellurium Copper	Good electrical and thermal conductivity. Excellent for parts requiring extensive machining. Relatively simple shapes. Used where parts are to be brazed in reducing atmosphere.	Same as electrolytic tough pitch copper.
	Group C: Nickel Silvers and Aluminum-Silicon Bronzes	
Nickel Silver	Simple shapes. Alloy is silver-white in color.	Architectural and decorative components.
Leaded Nickel Silver	Same as nickel silver.	Architectural and decorative parts requiring machining.
Aluminum-Silicon Bronze	High strength, excellent corrosion resistance, low coefficient of friction. Simple shapes. Good machinability. Readily forged.	Machine parts, aircraft and marine hardware, bearing surfaces.

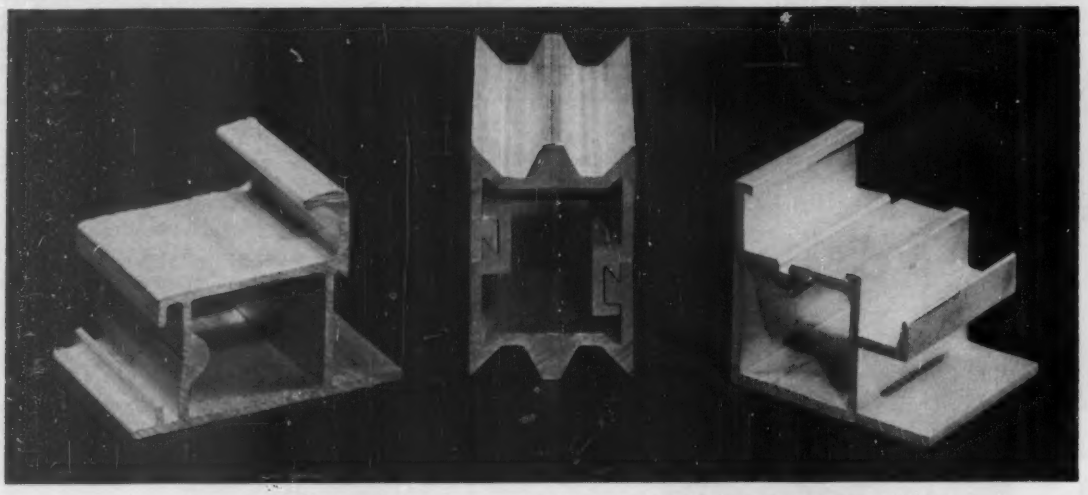


Fig. 4—Assemblies made up of more than one extrusion, held together by interlocking lugs. This method is often used for relatively large hollow parts.

ness, Fig. 3.

At present, most intricate copper-base extrusions are extruded solid. Some hollow parts, Fig. 4, are made up of one or more pieces held together by interlocking lugs, while others are finish-drawn from an extruded tube. Parts with sliding fits are regularly produced.

Slices may be cut from extruded shapes to make forging preforms, Fig. 5, thus minimizing the number of forging steps required.

Quality: Surface finishes of 250 mu in. can be expected for plain extrusions, and finishes of 125 mu in. for extruded-and-drawn parts. For those parts

Table 3—Composition and Typical Properties of Group C Alloys

	Nickel Silver	Leaded Nickel Silver	Aluminum-Silicon Bronze
ASTM Spec	.....	.....	B124, B150
Composition, Nominal (per cent)	Cu 43.25 Zn 43.60 Ni 13.0 Mn 0.15	Cu 45.0 Zn 42.0 Ni 10.0 Mn 2.0 Pb 1.0	Cu 90.75 Al 7.25 Si 2.0
Physical Properties			
Density (lb/cu in.)	0.301	0.303	0.278
Melting Temp (F)	.....	1700 (est)	1800
Coefficient of Thermal Expansion, 77 to 572 F (per deg F)	.....	11×10^{-6}	10×10^{-6}
Electrical Conductivity (per cent IACS)	.....	7	9.2
Thermal Conductivity at 68 F (Btu/hr/sq ft/ft/deg F)	.....	21	26
Mechanical Properties			
Tensile Strength (1000 psi)	60	60	98
Yield Strength* (1000 psi)	40	40	44
Elongation in 2 in. (%)	25	20	25
Hardness, Rockwell	B60	B60	B80
Fabricating Properties			
Cold Workability	Poor	Fair	Poor
Hot Workability	Excellent	Good	Excellent
Hot Working Temp (F)	1150 to 1500	1150 to 1500	1300 to 1600
Machinability Rating†	20	50	60
Intricacy Index§	55	60	50

*Value at 0.5 per cent extension under load.
†Based on free cutting brass = 100.
§Based on architectural bronze = 100.

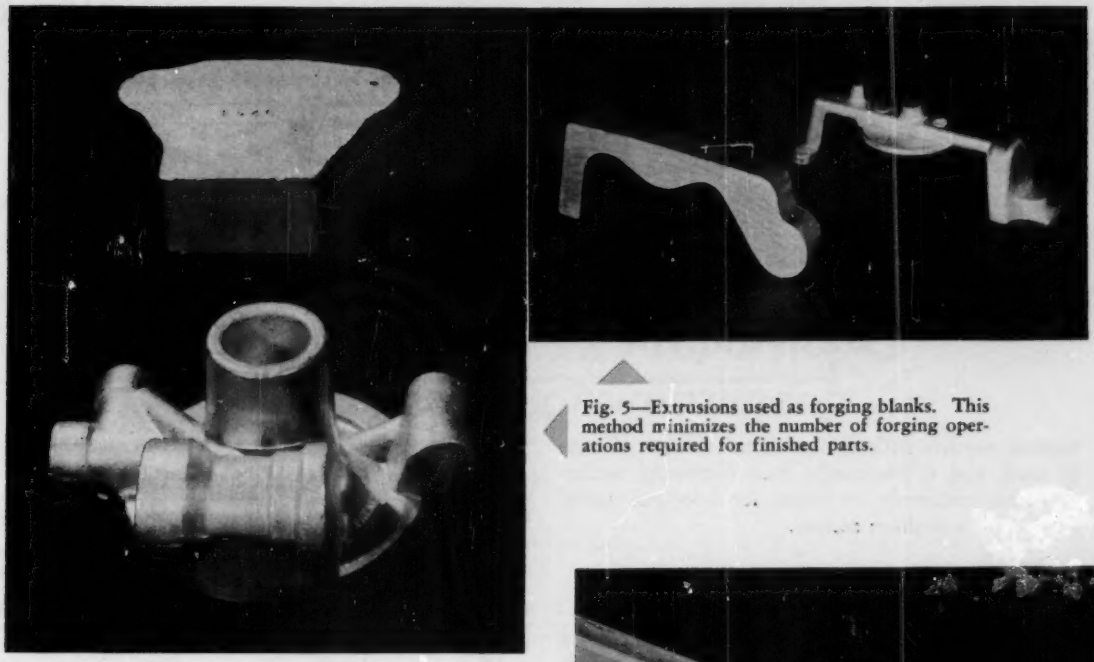


Fig. 5—Extrusions used as forging blanks. This method minimizes the number of forging operations required for finished parts.

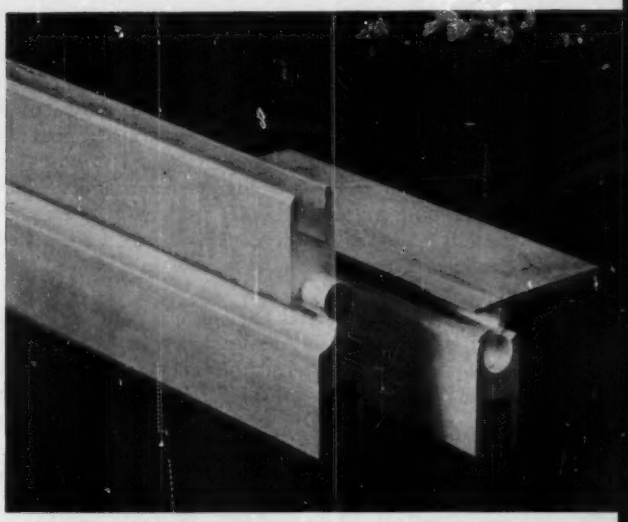


Fig. 6—Extruded continuous hinges. Very little machining is required on the as-extruded shapes.

requiring finish machining, free-cutting alloys—tellurium copper, free-cutting brass, or the other leaded brasses and bronzes—may be used.

Finish and Assembly: In addition to being available in different base-metal colors (yellow, red, or silver-white), copper alloys can be chemically etched or colored. They can also be plated, buffed, or polished. Copper-base alloys can be easily joined by brazing, soldering, or fusion welding. The leaded alloys are easily drilled and tapped for screw fasteners.

Design

Slot Limitation: Extruding temperatures of 1350 to 1700 F and pressures of 40,000 to 120,000 psi tax the strength of die materials to their limits, particularly when the die must have a deep, narrow tongue to form a groove or slot in the finished extrusion. For channels of moderate gauge, deep shapes can be produced by extruding the channels with the sides flared out in a V configuration, after which the legs are drawn in. However, when this technique is not possible because of the extrusion shape, it is usually necessary to limit depth-to-width ratios of slots and grooves to: Group A, 2:1; Group B, 1:1; Group C, 1:1.

These ratios are approximate values only. They can often be increased considerably, provided the cross-section of the shape allows. For example, although the approximate slot limitation for nickel silvers is 1:1, Fig. 3*b* shows a nickel-silver shape where the ratio is about 2:1.

Combination of Parts: Assemblies consisting of two or more parts fastened or joined together can sometimes be redesigned as a single extruded shape. Another approach, used occasionally for small shapes, is to combine two parts into a single extrusion which is subsequently cut apart. If small quantities of two or more similar shapes are required, it is frequently possible to incorporate the shapes into one die blank.

Other interesting extrusion applications are continuous hinge arrangements, Fig. 6, which require very little machining.

Tapered Sections: Because of metal-flow characteristics, a shape which has a long, thin, uniform section joined to a large solid section is difficult to extrude. However, if it is possible to replace the uniform section with a tapered section, the long, thin section can be made without difficulty. This

Table 4—Section Thickness

Circle Size (in.)	Minimum Thickness (in.)		
	Architectural Bronze	Naval Brass and Leaded Naval Brass	All other Group A Alloys, Groups B and C
To 2	1/16	3/32	1/8
3	5/64	1/8	5/32
4	3/32	5/32	3/16
5	7/64	3/16	1/4
6	1/8	1/4	5/16

method requires little change in the amount of metal used, and is less costly than increasing section thickness uniformly to allow for adequate metal flow to fill a uniform section.

Tolerances

Circle and Section Size: Maximum diameter of a circumscribing circle for copper-base extrusions is usually 6 to 7 in., but most intricate shapes are produced in circle sizes to 3 in., Fig. 7.

Because of metal-flow characteristics and pressure limitations, certain minimum section thicknesses are usually required. Minimum thicknesses for the various copper-base alloys are shown in Table 4.

Tolerances for Metal Dimensions: A metal dimension is defined as any dimension where 75 per cent or more of the dimension is metal. Although the standard tolerances listed, Table 5, are typical for most of the brass industry, tolerances on specific alloys and shapes may vary with individual mills.

Although Group A alloys are listed in Table 5 as "extruded" only (the usual condition in which they are supplied), they are also available in the extruded-and-drawn condition. In this condition, the tolerances for Group A materials are equivalent to those of the Group B alloys.

Tolerances for Space Dimensions: In addition to tolerances on metal dimensions, it is necessary to consider tolerances for space dimensions. A space dimension is any dimension where over 25 per cent of the dimension is space. These tolerances are approximately double those listed in Table 5.

Other Standard Tolerances: Angle tolerances are approximately ±1 deg for plain-extruded and ±1/2 deg for extruded-and-drawn shapes. Flatness tolerances are generally ±0.004 in. per inch of width for plain extruded shapes (±0.004 in. min) and ±0.002 in. per inch of width for extruded-and-drawn shapes (±0.002 in. min).

Curved-surface tolerances are ±0.005 in. per inch of chord length for plain extruded shapes (±0.005 in. min) and ±0.0025 in. per inch of chord length for extruded-and-drawn shapes (±0.0025 in. min). Cut ends have a tolerance

Table 5—Metal-Dimension Tolerances

Dimension (in.)	Tolerance, plus or minus (in.)		
	Group A (extruded)	Group B (extruded and drawn)	Group C (extruded)
To 1/4	0.005	0.003	0.010
1/4 to 1/2	0.005	0.003	0.015
1/2 to 1	0.007	0.005	0.020
1 to 2	0.010	0.008	0.025
2 to 3	0.015	0.010	0.030
3 to 4	0.020	0.015	0.035
4 to 5	0.030	0.020	0.045
Above 5	0.035	0.025	0.055

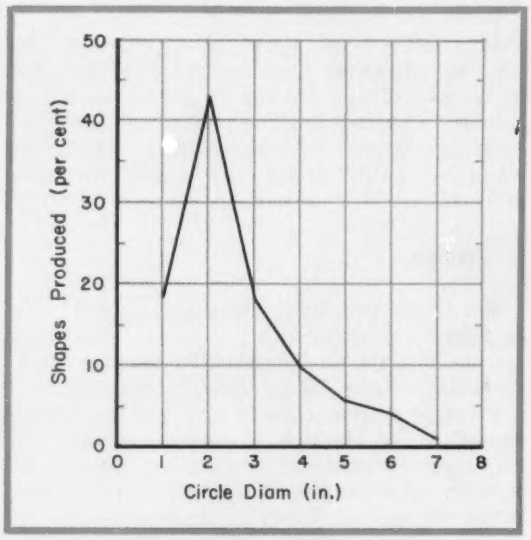


Fig. 7—Percentage of copper-base extrusions produced in each circle size. Extrusions below 1 in. are included in the 1 in. category.

of 1 deg from square, and corner-radii tolerances are usually ±1/64 in. for dimensions under 3/16 in., and approximately 10 per cent for radii above 3/16 in. The minimum radius for a sharp corner is about 0.010 in. Allowable twist is ±1 deg per foot. Straightness tolerances are 1/8 in. per 5 ft for parts with circumscribing circles of less than 3/4 in. diam, and 1/16 in. per 5 ft for larger shapes.

PIN-JOINT DESIGN

. . . a quick, direct method for matching joint proportions to operating requirements.

M. DEHA KORKUT
Design Engineer
Ocean Drilling and Exploration Co.
New Orleans, La.

PIN joints of the knuckle or clevis type, Fig. 1, are frequently used between load-carrying members to permit movement of the connection. In most joints of this type, the connected members are subjected to only axial forces and slow relative motions.

Design of pin joints, although seemingly simple and straightforward, can be quite time consuming. Data on standardized and recommended joint proportions have been published,[1, 2] and cover a limited range of joint sizes, types, and operating conditions. However, these designs are based on certain values of pressure in the bearing areas. When continuous film lubrication is used, and pressure requirements at the bearing surfaces differ from the standardized conditions, joint dimensions must be tailored to the specific situation.

A simplified design procedure has been developed to handle most of the requirements encountered in practice. Joint dimensions can be rapidly determined once the pressure at the bearing surfaces is established. The method is applicable to any pin joints, whether the materials of the pin, clevis, and eye elements are the same or not.

[1]References are tabulated at end of article.

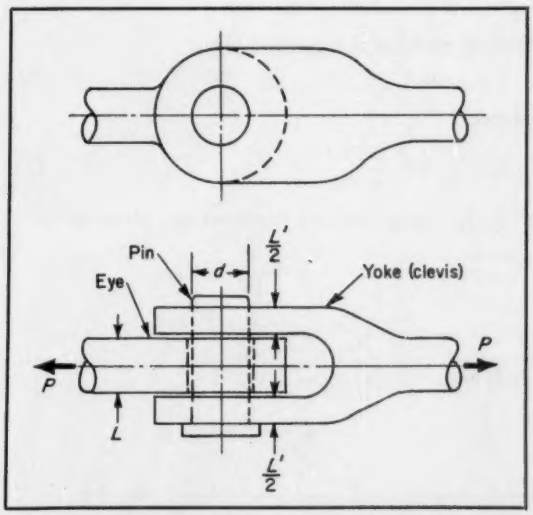


Fig. 1—Typical clevis joint. Clevis pin is usually headed at one end and held in place by cotter pin or keeper plate at shank end.

Basic Relationships: In a conventional pin connec-

Nomenclature

a	= Curvature coefficient
d	= Pin diameter, in.
k, k'	= Stress ratios
L	= Width of effective bearing surface in eye, in.
L'	= Total width of effective bearing surface in yoke or clevis, in.
M	= Bending moment in pin, lb-in.
m	= P/σ = Minimum area of eye section, sq in.
P	= Axial force, lb
p	= Bearing pressure on eye surface of pin, psi
p'	= Bearing pressure on yoke surface of pin, psi
R	= Outside radius of eye, in.
R'	= Outside radius of yoke, in.
r	= Inside radius of eye, in.
t	= R-r = Thickness of eye section, in.
Z	= Section modulus, in.^{3}
α	= Stress correction factor
β, β'	= Stress-pressure ratios
σ	= Maximum stress in eye, psi
σ'	= Maximum stress in yoke or clevis, psi
σ_o	= Bending stress in pin, psi
μ	= Proportionality factor

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tion, the maximum stress in the eye, Fig. 2, is[3] (see Nomenclature):

$$\sigma = a\frac{8P}{\pi^2 Rt} \qquad (1)$$

Curvature coefficient a varies from 4.30 to 4.39 as ratio R/r varies from 2 to 4. Maximum stress occurs at the inside edge of section A-A, Fig. 2.

A simpler and more convenient form of Equation 1 is:

$$\sigma = \alpha\frac{P}{Rt} \qquad (2)$$

where $\alpha = 8a/\pi$.[2]

Letting $m = P/\sigma$ and solving for R in Equation 2 reduces the expression to its simplest form:

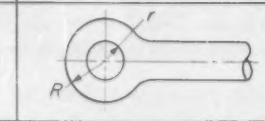
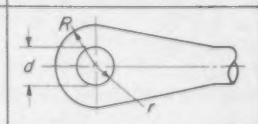
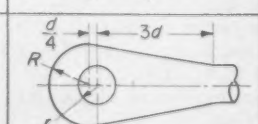
$$R = \frac{\alpha}{t}m \qquad (3)$$

For the range of a values previously mentioned, α is nearly constant and has an approximate value of 3.5. Thus, Equation 3 can be expressed in the conditional form,

$$R = \frac{3.5m}{t}, \qquad 2 \leqq \frac{R}{r} \leqq 4 \qquad (4)$$

In Equations 3 and 4, m represents the minimum required area of the eye section when it is loaded in tension only. From these equations, a suitable outside radius for the eye can be determined. Equation 3 and, within its limits, Equation 4 may be used for any pin joint of the type shown in Fig. 1, provided that the pin or bolt is fitted in the clevis, and clearances are not more than required for a free fit. By definition, conditions of such a fit are: Clearance = $0.0014\ (d^2)^{1/3}$, and pin (or bolt) tolerance = hole tolerance = $0.0013\ (d)^{1/3}$, where d = nominal pin diameter. When these fit conditions are met, results obtained with Equations 3 and 4 agree with theory[4] (in the elastic range) and with actual test results.

Table 1 - Values of α (R/r = 2.58)

Case	Eye Construction	Stress Correction Factor, α	
		Without Clearance*	With Clearance†
1		3.28	4.70
2		2.88	3.80
3		2.04	2.83

*Riveted connection and/or body-bound bolt or pin fit.
†1/64 in. clearance per in. of pin diameter.

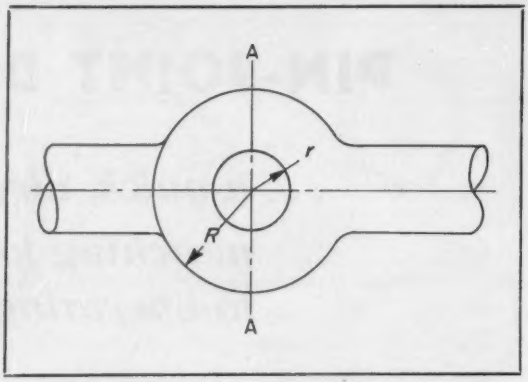


Fig. 2—Typical eye construction. Maximum stress is developed at inside edge of section A-A.

Results of tests conducted by Mathar[5] suggest three different eye designs and six different clearance conditions, Table 1. Equations, with stress concentration factors K as coefficients, are given by Mathar[5] and may be expressed in the form of Equation 2. Corresponding values of α are given in Table 1. For Case 1 in Table 1, the α values agree with the values given by Timoshenko.[3, 4]

Joint Design: In the type of joint shown in Fig. 1, the pin, as a rule, is fixed in the clevis or yoke member and the eye can be easily moved around the pin. Bearing pressures on the eye and the yoke surfaces of the pin are usually either known or chosen beforehand. The bending moment in the pin, Fig. 1, is given by[6]

$$M = \frac{P}{8}(L + L') \qquad (5)$$

Section modulus of the round pin is

$$Z = 0.098d^3 \qquad (6)$$

Hence,

$$\sigma_o = \frac{M}{Z} = \frac{P\ (L + L')}{0.785d^3} \qquad (7)$$

If the design bearing pressures are given by

$$p = \frac{P}{Ld}$$

$$p' = \frac{P}{L'd}$$

and, also,

$$\beta = \frac{\sigma_o}{p}$$

$$\beta' = \frac{\sigma_o}{p'}$$

$$\mu = \frac{L'}{L} = \frac{\beta'}{\beta} = \frac{p}{p'}$$

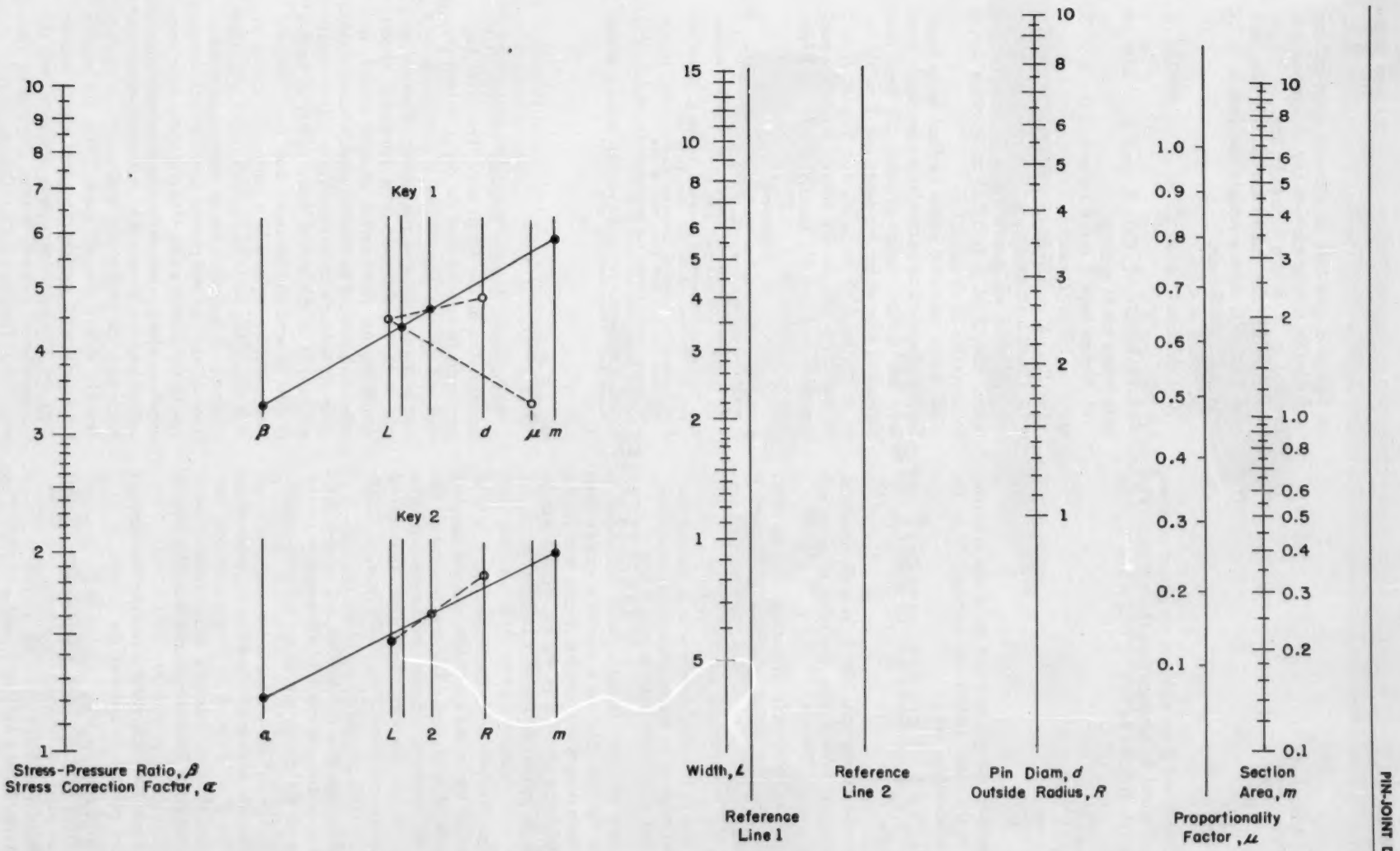


Fig. 3—Joint-design nomograph, which provides direct solution of Equations 8 and 9.

then

$$L^4 = \frac{0.785\beta^3 m^2}{1+\mu} \quad (8)$$

and

$$d = \beta\frac{m}{L} \quad (9)$$

Equations 8 and 9 are sufficient for design purposes, and are solved in nomograph form in Fig. 3. This nomograph also can be used to find R and R', from

$$R = \alpha\frac{m}{L} \quad (10)$$

$$R' = \alpha\frac{m}{L'} \quad (11)$$

Sometimes, the pin may not be of the same material as the clevis and/or eye members. If so, the stress relationships are

$$\sigma = k\sigma_o \quad (12)$$

$$\sigma' = k'\sigma_o \quad (13)$$

To use the nomograph, Fig. 3, in such situations, the α-scale is entered with the value of either α/k or α/k'.

As defined previously (Equation 4), the limit condition for the design procedure given here is $1 \leqq R/d \leqq 2$. If R or R' does not satisfy this condition, the recommended alternatives are

1. If $R/d > 2$, modify either α or μ by changing the joint design or the bearing pressure ratio, respectively.
2. If $R/d < 1$, modify design to make $R = d$.

In most pin-joint designs, grease lubrication is used in the eye. Also, as a rule R is smaller than R'. If such designs are modified so that $R = R'$, the extra thickness provided in the eye usually will be enough to permit the use of a bushing.

Design Example: A pin connection, Fig. 1, is to be designed in which the eye, clevis, and pin members are made of mild steel. The pin is fitted in the clevis and maximum clearance in the eye is 1/64 in. per in. of pin diameter. Determine the required joint proportions where P = 60,000 lb, σ_o = 12,000 psi, p = 6000 psi and p' = 12,000 psi.

By definition, β = 12,000/6000 = 2, m = 60,000/12,000 = 5, and μ = 6000/12,000 = 0.5.

Steps of the design procedure, using the nomograph in Fig. 3, are:

1. On the nomograph (see Key 1), connect the points for β = 2 and m = 5 with a straight line. Note that this line intersects both reference line 1 (reference point 1) and reference line 2 (reference point 2).
2. From μ = 0.5, draw a straight line through reference point 1 to intersect the L-scale.
3. Read L = 3.2 in.
4. From L = 3.2, draw a straight line through reference point 2 to intersect the d scale.
5. Read d = 3.15 in.
6. From Table 1 for Case 3, read α = 2.83. This eye design is used here to minimize stress buildup.
7. On the nomograph (see Key 2), connect α = 2.83 and m = 5 with a straight line.
8. Through the intersection of this line with reference line 2, draw a straight line from L = 3.2 to intersect the R-scale.
9. Read R = 4.4 in.
10. Calculate L' from: $L' = \mu L$ = 0.5(3.2) = 1.6 in.
11. From Table 1, Case 3, read α = 2.04 for body-bound pin fit in clevis.
12. Repeat steps 7 and 8 for α = 2.04, m = 5, and L' = 1.6 in. (L scale).
13. Read R' = 6.35 in. (R scale).
14. Check limit conditions. First check is: R/d = 4.4/3.15 = 1.4, which falls within the recommended range. Also, R'/d = 6.35/3.15 $\approx$ 2, which should be acceptable for design.
15. Adjust calculated values for final design specification. Based on recommendations previously given here and general design practice, the final joint dimensions selected for this design are: L = 3¼ in., L' = 1¾ in., $L'/2$ = ⅞ in., d = 3¼ in., R = 5 in. and R' = 6⅜ in. For reasons previously mentioned, $R = R'$ = 6⅜ in. may also be used here.

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4. S. Timoshenko—*Theory of Elasticity*, Second Edition, McGraw-Hill Book Co. Inc., New York, 1951, p. 123.
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6. *Dubbel's Taschenbuch fur den Machinenbau: Volume* 1, Springer-Verlag, Berlin (West Germany), 1958, p. 209.

They Say . . .

"Management becomes seriously involved in instrumentation at the design stage. The Chief Engineer must be satisfied that the design is both practical and efficient. The selection of instruments for a new design can give rise to a number of possibilities: will it be an electronic or a pneumatic system, should we use flow control or level control, will reflux be controlled by volume or temperature, should it be an indicator or a recorder, will it be locally mounted or in the control room, should we have a graphic or semi-graphic panel, how many temperature points are required in a reactor . . . and so on. It is also at this point that human nature very often shows up. It is natural for an operator to prefer to have all readings and control functions at his finger tips in the control room. However there have been instances where a process was so completely instrumented and ran so smoothly that the operators lost touch with the process and were unable to cope effectively with a process upset. These are matters for management consideration and a neat balance must be struck between costs, efficiency and the human element."—RENE SIMARD, *Engineering Div., Imperial Oil Ltd., Sarnia, Ont., Canada.*

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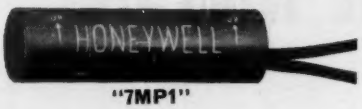

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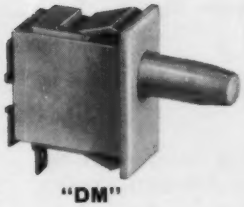

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How to find the best value in

Selecting Lightweight Metals

R. E. JOHNSON
Design Engineer
General Dynamics Corp.
Convair Div.
Fort Worth, Texas

AS an aid to the selection of economical materials, a new factor has been derived to include the interaction of strength, density, and cost. This factor is determined by dividing strength by the product of cost and density. When plotted against temperature, the new factor rearranges the usual rankings of metals into various regimes and gives a rapid comparison on a "value" basis.

This paper presents this ratio plotted versus temperature for metals which have shown promise for elevated temperature usage up to 2800 F. In addition, a simplified formula for determining the cost per pound of weight savings is derived and examples of its use are given.

For any group of metals being considered for certain applications, the strength-to-weight ratio is generally used to rapidly compare material strengths corrected to a common density. These ratios can be plotted against temperature to show where it is advisable to go from aluminum to steel or titanium. The new ratio rearranges the curves. What material looked good on a strength-to-weight basis may not be a good material when cost is considered. The new ratio yields the best compromise of strength, density, and cost.

To illustrate this effect, plots of ultimate tensile strength to weight are given in Fig. 1 for two nickel base alloys, a high-strength heat-treated titanium alloy, and a precipitation-hardening steel. According to Fig. 1, the titanium alloy is the best material on a strength-to-weight basis up to about 900 F where instability begins. From there to 1600 F, the nickel base alloy, Rene' 41, is the best. This family of curves is adjusted for the cost of the respective alloys in Fig. 2. Here, the PH 15-7 Mo stainless steel appears to be the best value up to 1000 F.

This type of analysis can be used to rapidly screen out metals for uses in various temperature regimes. Data for certain refractory metals

Table 1—High-Temperature Properties of Refractory Metals

Temperature (F)	Ultimate Tensile Strength (1000 psi)	Strength / Density (1000 in.)	Strength / Density × Cost (100 in.-lb/dollar)
	10 Ti 10 Mo 80 Columbium (Density: 0.292 lb per cu in.; Cost: $150 per lb)		
1600	57	195	13
1800	48	165	11
2000	35	120	8
2200	25	86	5.8
2400	18	62	4.1
2600	10	34	2.3
	0.5 Ti Molybdenum (Density: 0.369 lb per cu in.; Cost: $40 per lb)		
1600	88	239	60
1800	80	217	54
2000	63	170	42
2200	45	122	30
2400	25	68	17
2600	16	43	10.7
2800	12	32.5	8.1
	10 W 90 Tantalum (Density: 0.610 lb per cu in.; Cost: $60 per lb)		
1600	105	172	29
1800	93	152	25
2000	80	131	22
2200	67	110	18.2
2400	48	79	13.2
2600	20	33	5.5

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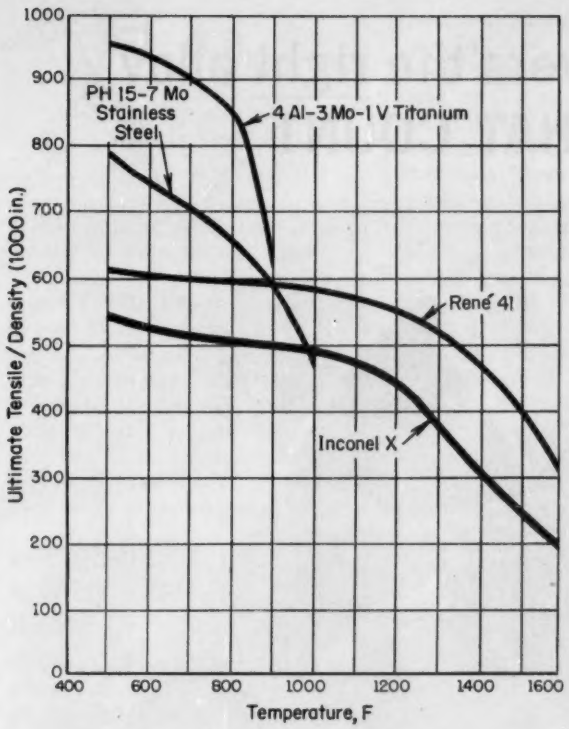

Fig. 1—Strength ratio for lightweight alloys.

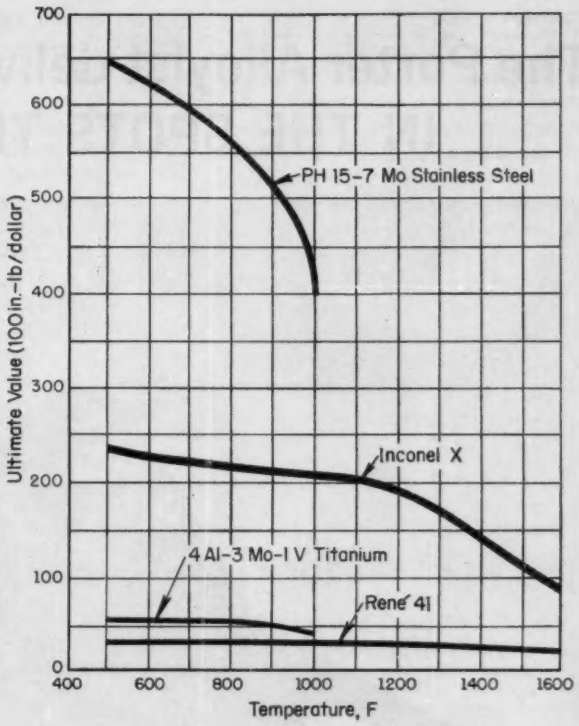

Fig. 2—Value ratio for lightweight alloys.

are given in Table 1. Fig. 1 and 2 can also be used to make a quick estimate of how much a pound of weight saved actually costs:

1. At design temperature, pick off the best "value" material from Fig. 2.
2. From Fig. 1, at the same temperature, find all materials above the metal chosen in step 1. These are materials where weight savings can be realized at a cost sacrifice.
3. To determine the cost, S, in dollars per pound of weight saved, use the formula,

$$S = \frac{\frac{\sigma_1}{\sigma_2}\rho_2 C_2 - \rho_1 C_1}{\rho_1 - \frac{\sigma_1}{\sigma_2}\rho_2}$$

where σ = stress at temperature, 1000 psi; ρ = density, lb per cu in.; C = raw material cost, $ per lb; subscript 1 identifies best value material, and subscript 2 identifies lighter material.

Example 1: At a design temperature of 800 F, best value from Fig. 2 is PH 15-7 Mo stainless steel, for which ρ = 0.277 lb per cu in. and C = $1.24 per lb. Lightest material from Fig. 1 is 4 Al-3 Mo-1V Titanium, for which ρ = 0.163 lb per cu in. and C = $15.50 per lb. Hence, σ_1 = 186, ρ_1 = 0.277, C_1 = 1.24, σ_2 = 148, ρ_2 = 0.163, C_2 = 15.50. By substitution in the value equation,

$$S = \frac{\frac{186}{148}(0.163)(15.50) - 0.277(1.24)}{0.277 - \frac{186}{148}(0.163)}$$

Example 2: At a design temperature of 1000 F, best value from Fig. 2 is Inconel X, for which ρ = 0.298 lb per cu in. and C = $2.30 per lb. Lightest material from Fig. 1 is Rene' 41, for which ρ = 0.298 lb per cu in. and C = $16.20 per lb. Hence, σ_1 = 147, ρ_1 = 0.298, C_1 = 2.30, σ_2 = 174, ρ_2 = 0.298, C_2 = 16.20. By substitution in the value equation,

$$S = \frac{\frac{147}{174}(0.298)(16.20) - 0.298(2.30)}{0.298 - \frac{147}{174}(0.298)}$$

= $72.40 per lb of weight saved

The analysis shown in this paper is based on ultimate tensile strength. The same type analysis could be applied to yield strength, shear, compression, or buckling.

SAWE Technical Paper No. 287, "Maximum Strength—Minimum Weight and Cost—How?" presented at the SAWE 20th National Conference, Akron, Ohio, May 1961, 13 pp.

materials

Properties of Glass Fibers At Elevated Temperatures

William H. Otto, Narmco Research and Development, San Diego, Calif.

Fibers of four glass compositions, evaluated on the basis of measured tensile strength, stress-rupture, and modulus of elasticity at elevated temperatures.

Measurements on "E" glass, a higher temperature experimental composition, a high modulus glass, and fused quartz show that tensile strength decreases as the temperature increases up to the softening temperature of each glass. Permanent changes in physical properties, resulting from exposure of glass fibers to high temperatures, are discussed. For example, heat

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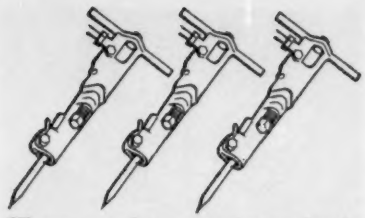

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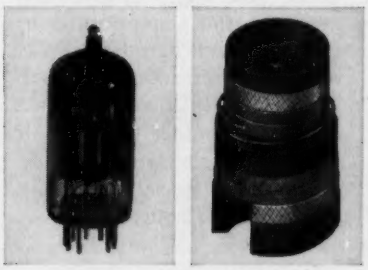


PORTER nickel wire is used extensively in vacuum tubes and in other components for the electronics industry.

PORTER carbon steel wire reinforces hose for air hammers and other industrial equipment.

PORTER

RIVERSIDE-ALLOY METAL DIVISION
H. K. PORTER COMPANY, INC.

Circle 282 on Page 19

treatment causes a loss in strength at 75 F, but increases the modulus of elasticity as much as 15 per cent.

With the exception of silica, modulus of elasticity of thermally stabilized fibers decreases as temperature increases, reflecting the lower density which is a result of thermal expansion. Stress-rupture measurements at load durations ranging from one minute to twenty hours show that strength decreases as a logarithmic function of time at all temperatures from 75 F to the softening temperature of the glass.

SAMPE paper, "Properties of Glass Fibers at Elevated Temperatures," presented at SAMPE Filament Winding Symposium, Pasadena, Calif., March, 1961, Symposium Papers pp. 32 to 47.

processes

Press Forming and Welding of Heavy Magnesium Plate

R. A. Matuszeski, general supervisor, and A. J. Kish, senior mechanical engineer, Development and Test Engineering Dept., ACF Industries, Inc., Albuquerque, N. Mex.

Techniques used to press form one to two-inch-thick AZ31B magnesium and the resultant properties of the pressed shape.

Also, a discussion of welding technique and across-weld properties is presented for one-inch-thick AZ31B, as well as general discussion on welding thicker plate of the same alloy.

Conclusions on press forming are:

1. The press-forming method of fabrication is practical for making deep-drawn shapes from thick plate.
2. Mechanical properties typical of the "-H24" condition can be obtained from original annealed material after fabrication by press-forming.
3. The optimum working range for plate stock is between 600 and 650 F. Forming of thick plate should be performed with slow hydraulic press speeds.
4. The metal is worked very uniformly by this method of fabrication. Pronounced directional properties and accumulated internal strains are definitely lessened by heating between intermediate draws. Forming temperatures of each subsequent stage should be reduced 50 deg F.
5. This method of fabrication is conducive to maintaining close tolerances in subsequent machining operations.

Based on the analysis of the tensile data and micro and macro examination, it is evident that a satisfactory finished shape can be produced with very slight variations in wall thickness throughout the entire cross section of the pressing. It is hoped that this information will induce future consideration of the many potentials offered by this fabrication method which can be utilized for production of shapes of substantial wall thickness.

ASME Paper No. 61-SA-18, "Press Forming and Welding of Heavy Magnesium Plate," presented at the Summer Annual Meeting, Los Angeles, June, 1961, 8 pp.

mechanical

Design and Properties of Constant-Diameter Cams

Karl Brunell, senior project engineer, Bell and Howell Co., Lincolnwood, Ill.

Some basic properties which govern the design of constant diameter cams and open cams with flat-faced translating followers.

It is shown that the radius of cam curvature is the governing criterion and its proper use enables design of constant-diameter cams for any desired dynamic characteristic.

ASME Paper No. 61-SA-2, "Constant Diameter Cams, Their Properties and Design Characteristics," presented at the Summer Annual Meeting, Los Angeles, June, 1961, 4 pp.

Tensions in Straight and Curvilinear Belt Conveyors

W. A. Winkler, senior design engineer, Utah Construction and Mining Co., Palo Alto, Calif.

A simplified method for tension calculations in belt conveyers, suggesting the same approach regardless of whether belts are straight or curvilinear.

A key diagram is introduced for the quick identification of critical tensions for all basic conditions.

It is common practice to use an analytical method for the calculation of tensions and horsepower of more complicated belt conveyers, especially curvilinear belt conveyers. The big advantage of this method is that it permits the establishment of tension values for the design of

concave and convex curves and also for the design of drive and take-up when not located at conveyer ends. However, the so-called analytical method has a distinct disadvantage in practical engineering—it is tedious and time-consuming.

The purpose of this paper is to present a faster way to find all belt tensions necessary for the proper design or selection of conveyer components.

ASME Paper No. 61-SA-11, *"Tensions in Straight and Curvilinear Belt Conveyors," presented at the Summer Annual Meeting, Los Angeles, June,* 1961, 5 *pp.*

Maximum Stresses in Beams and Plates Vibrating at Resonance

Eric E. Ungar, senior engineering scientist, Bolt Beranek and Newman, Inc., Cambridge, Mass.

Expressions which relate the maximum stresses encountered in simply supported beams and rectangular plates and in clamped circular plates vibrating at resonance to modal displacements and modal loadings.

Computation of modal loadings from time-wise harmonic or random pressures is discussed. It is shown that the resonant maximum stress may be reasonably approximated by a simple formula suitable for conservative design calculations for all types of beams and plates.

ASME Paper No. 61-SA-14, *"Maximum Stresses in Beams and Plates Vibrating at Resonance," presented at the Summer Annual Meeting, Los Angeles, June* 1961, 7 *pp.*

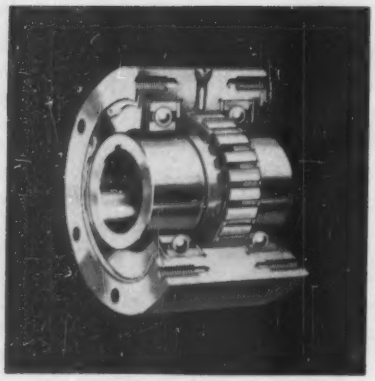
techniques

Rectilinear Motion from Mechanical Function Generators

Bernard W. Shaffer, professor of mechanical engineering, New York University, New York, and Irvin Krause, research scientist, American Standard, Union, N. J.

A general method for generating controlled rectilinear motion to any desired accuracy.

The method is based upon the expansion of the required displacement-time relationship into an infinite Fourier series and the design of epicyclic gear trains to generate terms of the series. The use of Fourier series is comparatively



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HPO CLUTCHES

Exclusive chromium-carbide alloy "Formchrome" sprags held in precise position with a new retainer design permit up to *30% higher operating speeds* with the same life span and up to *70% longer clutch life* when operated at same RPM as ordinary clutches.

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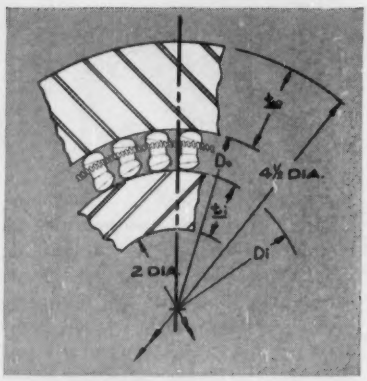

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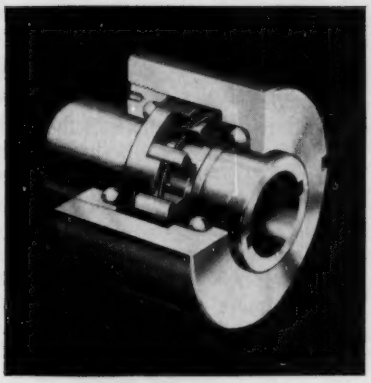

Positive Positioning

R⊥L

reverse lock clutches

With the R-L reverse lock clutch you can position a load precisely and be sure it will not move. The reason lies in the design that permits torque to be transmitted from the power source to the load in either a clockwise or counterclockwise direction but not from the load back to the power source.

Wide Choice of Capacities—Standard models currently available provide torque capacities from 40 lbs. in. to 30,000 lbs. in. Bores and shaft sizes range from ¼" to 2½".

Typical Applications—Examples of drives benefiting from the positive positioning feature include: radar antenna drives, timing drives, machine tool applications in which cutter bar must be accurately positioned along lead screw, etc.

Get more data by writing for Catalog RL-101.

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nonrestrictive. Although for purposes of demonstration, it was assumed that a functional relationship existed between displacement and time, it is entirely possible to utilize Fourier series when this relationship is given in tabular or graphical form.

The method may be used with equal facility whether or not the motion is cyclic. In the case of noncyclic operation, it is generally more convenient to express the output displacement in terms of the input angle θ rather than as a function of time.

The approximation of the displacement-time relationship $x(t)$, by means of a finite number of terms of the Fourier series, makes it possible to predict the displacement at any time during the cycle of operation. More important, however, is the fact that the velocity and acceleration may also be uniquely determined at any time by differentiation of the finite series used to approximate $x(t)$.

ASME Paper No. 61-SA-4, "Synthesis of Rectilinear Motion by Mechanical Harmonic Function Generators," presented at the Summer Annual Meeting, Los Angeles, June, 1961, 9 pp.

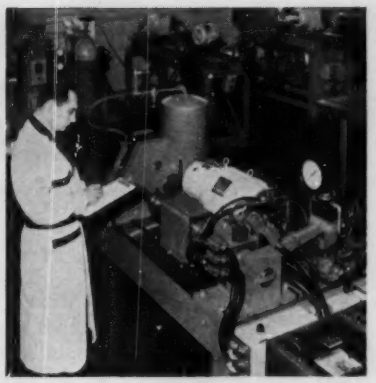
Filament Winding Design

Jonas Medney, J. Lowrie McLarty, and Charles B. Kurz, Lamtex Industries Inc., Long Island, N. Y.

Design parameters and a qualitative design study for filament-winding technique.

Filament-wound fiberglass epoxy structures have developed the highest strength-to-weight ratio of any known structural material. To achieve these results, it has been necessary to add a fourth dimension to the design of these wound structures. This new dimension, or design criteria, concerns the fiber orientation and proportion within the particular structure.

The basic design method is to orient the fibers in the direction of the principal stresses and proportion the number of fibers with respect to the size of the principal stresses. In cases where it is geometrically impossible to orient the fiber precisely in the direction of the principal stresses, they are oriented at some angle with the principal



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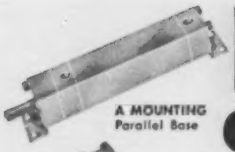
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Parallel Base

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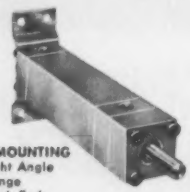
CLASS 7 CYLINDERS
7 Universal Mountings
ONE BASIC BODY

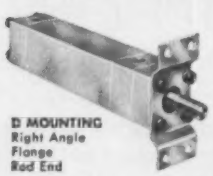
BB MOUNTING
Barrel Bolted

This is the only truly modular cylinder that is mass produced, yet gives you all the installation advantages of a custom-built unit. Any stroke length from 1" to 20" is immediately available in bores from ¾" to 3." Pressure rated for 200 p.s.i., air; 1000 p.s.i., oil, in the most popular stroke lengths.


C MOUNTING
Right Angle
Flange
Blank End

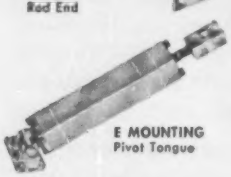
Roll 'em Over!

UNIQUE SQUARE BARREL†: Made of seamless extruded, aluminum alloy, drawn to a 16 micro inch finish, hard anodized to assure an extremely durable surface. Life tests reveal no wear in bore after millions of cycles. The four-square flush barrel provides unique and exclusive opportunity for direct bolt-in mounting into any of its sides or longitudinally from either end. (See Mounting HB & BB.)


D MOUNTING
Right Angle
Flange
Rod End

Blitz Bolt 'em!

NO TIE RODS! NO LOCK RINGS! All components including Mounting Attachments neatly contained by only four (4) bolts at each end.


E MOUNTING
Pivot Tongue

Shine 'em up!

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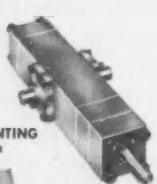
F MOUNTING
Trunnion

Hang one on!

MOUNTINGS UNLIMITED: — The 5 Universal Mounting Attachments are quickly bolted to the basic body. In addition, the four-square design allows rotating and inter-mixing these attachments. Now add to this the exclusive Direct Head Bolt and Barrel Bolt Mountings and NOPAK Class 7 becomes the most universal air and hydraulic cylinder ever developed. A natural for even the most difficult applications.

HB MOUNTING
Head Bolted

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CYLINDER HEADS: — as well as head plate, are precision cast and machined aluminum alloy. The four-square heads can be readily rotated to position ports for most convenient piping. No matter how rotated, the heads align perfectly with the square barrel, resulting in clean, flush surfaces. Heads also provide opportunity for direct bolt-in mounting. (See Mounting HB.)

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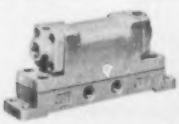
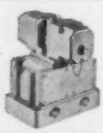


NOPAK "V" 4-Way, Pilot Operated Slide Valves Small, compact, 3- and 4-way valves for direct or remote control. Either single or double air pilot or solenoid actuated. Simple, proven design, durable construction insure trouble-free operation.



NOPAK - MATIC Poppet Type, Pilot Operated Valves Fast acting, high volume air valves from ¼" to 1¼" with master (air piloted) single or double solenoid. Side or bottom ported sub-plates or manifolds. Removing cover plates affords easy access to piston poppets housed within removable, interchangeable cartridges. 100% J.I.C.

†Patent Pending

*Cylinders, Valves, Accessories. NOPAK offers a complete line of matched Fluid Power components.

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stress. By using two different winding angles—low helicals and circumferentials—and calculating the proportion of fibers in both winding directions, a balanced structure can be achieved. The balanced structure is one in which the fibers in any direction in the structure have equal stress applied to them under load. The ultimate stress of the structure can be calculated using a fiber tensile stress of approximately 350,000 psi. The composite density of the finished laminates is in the range of 0.075 lb/cu in. and the resulting strength-to-weight ratio in composite structures can exceed 2,000,000 in.

SAMPE paper, "Designing with Filament Winding," presented at the SAMPE Filament Winding Symposium, Pasadena, Calif., March, 1961, Symposium Papers pp. 237 to 245.

Superposition of Stress-Concentration Factors

Frank W. Paul Jr., Mixing Equipment Co. Inc., Rochester, N. Y., and Thomas R. Faucett, professor of mechanical engineering, University of Missouri, Rolla, Mo.

A photoelastic study of the superposition of stress-raising notches.

Recent investigations have indicated that where one stress-raising notch is placed in the region of maximum influence of a second notch the resulting stress-concentration factor may be determined by taking the product of the concentration factors for the individual notches. Test results presented gave general although not precise agreement with this method of combination.

Tests were performed on specific materials for static and repeated loads, and hence combine the effects of stress concentration with the sensitivity of the particular material. Other tests run on a brittle material indicate the same general agreement.

Normal practice for applying stress-concentration factors separates the two effects, i.e., the actual concentration of stress and the sensitivity of the material to such concentration. It was believed that photoelasticity might yield a better verification of the method for combining superposed stresses as photoelastic methods have shown close agreement with theoretical factors of

stress concentration. Results of the present investigation indicate that the product gives the combined concentration factor with the same degree of accuracy to which the individual factors are known.

ASME Paper No. 61-SA-5, *"The Superposition of Stress Concentration Factors," presented at the Summer Annual Meeting, Los Angeles, June,* 1961, 4 *pp.*

Simultaneous Heat Transfer By Conduction and Radiation

R. Viskanta, assistant mechanical engineer, Argonne National Laboratory, Argonne, Ill., and R. J. Grosh, professor of mechanical engineering, Purdue University, Lafayette, Ind.

Heat transfer by simultaneous conduction and radiation in a thermal radiation absorbing and emitting medium.

Consideration is given to a one-dimensional system consisting of two, diffuse, nonblack, infinite, isothermal, parallel plates separated by a finite distance. The space between the plates is filled with a thermal radiation absorbing and emitting medium. The problem is formulated in terms of a nonlinear integro-differential equation and the solution is obtained by reducing it to a nonlinear integral equation. The numerical results are obtained by an iterative method. The temperature distributions and heat transfer are calculated. Two approximate methods for formulating radiant heat-transfer problems are presented and comparisons of the results are made with the most exact solution.

ASME Paper No. 61-SA-34, *"Heat Transfer by Simultaneous Conduction and Radiation in an Absorbing Medium," presented at the Summer Annual Meeting, Los Angeles, June,* 1961, 10 *pp.*

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SAMPE—Society of Aerospace Material & Process Engineers, P. O. Box 613, Azusa, Calif.

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Helpful Literature for Design Engineers

For copies of any literature listed, circle Item Number on Yellow Card—page 19

Hex-Head Cap Screws

Points out that hex-head cap screws, made to ASA Standard B-18.6.2, outperform both hex bolts and hex screws. Hex-head cap screw is also designed for a tapped hole as well as for a nut. Brochure also describes specific design features which make the hex-head cap screw superior to the other fasteners. Form 2788, 12 pages. Cleveland Cap Screw Co., 4444 Lee Rd., Cleveland 28, Ohio.

Circle 401 on Page 19

Industrial Retaining Rings

Contains information on industrial retaining-ring line, with dimension tables, engineering specifications, and mechanical drawings. Also includes information on wire stacking of Series 3000, 3100, 4000, and 4100 rings, as well as on rod stacking of Series 1000, 1200, and 2000 units. Separate 24-page price list is included. Catalog 61, 24 pages. Industrial Retaining Ring Co., 57 Cordier St., Irvington, N. J.

Circle 402 on Page 19

Vacuum Metallizing

Advantages of vacuum-metallizing over other metal-deposition techniques are set forth, and a large number of current applications are illustrated. Suggestions on lacquering and filament arrangement are given, as well as complete specifications for latest vacuum-metallizing equipment. Bulletin 584, 16 pages. F. J. Stokes Corp., 5500 Tabor Rd., Philadelphia 20, Pa.

Circle 403 on Page 19

Speed Reducers

Provides data on single-reduction, right-angle, spiral bevel gear speed reducers of both horizontal and vertical design. Includes formulas for gear speed-reducer selection, guide for determining load characteristics of more than 160 applications, and examples of reducer selection. Complete specification tables, rating charts, and dimensional drawings are provided for single reduction units with input speeds from 100 to 1750 rpm; ratios from 1:1 to 6:1, and horsepower capacities from 0.14 to 336. Catalog 42C, 24 pages. D. O. James Gear Mfg. Co., 1140 W. Monroe St., Chicago 7, Ill.

Circle 404 on Page 19

Strain Recording

Describes the application of strain gages and strain-gage-based transducers for recording strain, tension, thrust, load, and torque. Basic strain-recording circuits are shown for recording from one, two, or four active gages; techniques used to obtain precise recording of static and dynamic strain phenomena are explained. Various types of strain gages are presented, and an appendix provides a guide for the selection of specific gages. Form SR, 20 pages. Brush Instruments Div., Clevite Corp., 37th & Perkins Avenue, Cleveland 14, Ohio.

Circle 405 on Page 19

Magnetic Metals

Contains material on permeability and core loss of High Permeability 49 and HyMu 80 alloys at both 60 and 400 cycles. Also describes selection and use of test methods, magnetic behavior of metals, and the various alloys tested. Bulletin B-3, 40 pages. Magnetic Metals Co., Hayes Avenue at 21st Street, Camden, N. J.

Circle 406 on Page 19

Metal Seals

Gives sizes, specifications, test results, installation and ordering instructions, materials, and finishes of K-Seal line, including AN port seals, external pressure or vacuum seals, miniature seals, and flange seals. Handbooks and technical bulletins on Astro-Weight fittings for missile plumbing, internal metal seals, and vacuum-test data relating to extreme missile environment are included. 38 pages. Harrison Mfg. Co., 2908 Naomi St., Burbank, Calif.

Circle 407 on Page 19

Directional Control Valves

Covers line of two, three, and four-way directional control valves in sizes from ½ to 3 in. for pressures to 3000 psi. Information includes construction features, dimension data, capacity and specification data, flow diagrams, ASA symbols, and type designation for all sizes and types. Bulletins 80200-A, 80300-A, 22 pages. Oilgear Co., 1570 W. Pierce St., Milwaukee 4, Wis.

Circle 408 on Page 19

Mica Capacitors

Button-Mica capacitors are suitable for VHF and UHF applications in the temperature range of −55 to +85 C. Bulletin describes 90 variations of the resin-sealed units, and includes a cross-reference chart. Bulletin 318-2, 18 pages. Erie Electronics Div., Erie Resistor Corp., 645 W. 12th St., Erie, Pa.

Circle 409 on Page 19

Bellows, Bellows Assemblies

New assemblies are used in both high and low-pressure liquid and gaseous piping systems. Bulletin describes various types, points out pertinent features. Includes list of terminology. Bulletin 611-B, 4 pages. Avica Corp., Box 180, Newport, R. I.

Circle 410 on Page 19

Epoxy Products

Contains technical data on Helix bonding agents, potting compounds, sealants, coatings, and accessories. New products include those for use in high temperatures and where light weight is needed, those providing thermal-conductivity, and one-component formulations. Catalog 1961, 48 pages. Carl H. Briggs Co. Inc., 1547 14th St., Santa Monica, Calif.

Circle 411 on Page 19

Tolerance Ring

Covers definition, function and types of Star tolerance ring. Includes data on mountings, nomenclature, torque slippage, vibration and pounding, selection, and axial resistance. Complete dimension lists are incorporated, and drawings are included to show various applications. Catalog SFTR, 18 pages. Roller Bearing Co. of America, Sullivan Way, West Trenton, N. J.

Circle 412 on Page 19

V-Band Couplings

Gives specific cost comparisons between V-bands and other joining methods, and also lists savings in weight and installation or assembly time effected by use of the V-bands. Adaptability of design is also discussed. Booklet SDP-2, 16 pages. Marman Div., Aeroquip Corp., 11214 Exposition Blvd., Los Angeles, Calif.

Circle 413 on Page 19

Profilometer Instrumentation

Covers standard line of Profilometer instrumentation for the measurement and control of surface roughness. Includes detailed descriptions and specifications of various units. Many special products are also illustrated and described. Catalog 161, 12 pages. Micrometrical Mfg. Co., 3621 S. State Rd., Ann Arbor, Mich.

Circle 414 on Page 19

Miniature Gears

Offers broad line of stock miniature gears in Precision I, II, and III classes. Includes many new items and sizes. Also provides complete specifications for stock precision clamps, bearings, shafts, retaining rings, roll pins, and related electromechanical devices. Catalog 6A, 256 pages. Perfect Gear & Instrument Corp., 339 South Isis Ave., Inglewood, Calif.

Circle 415 on Page 19

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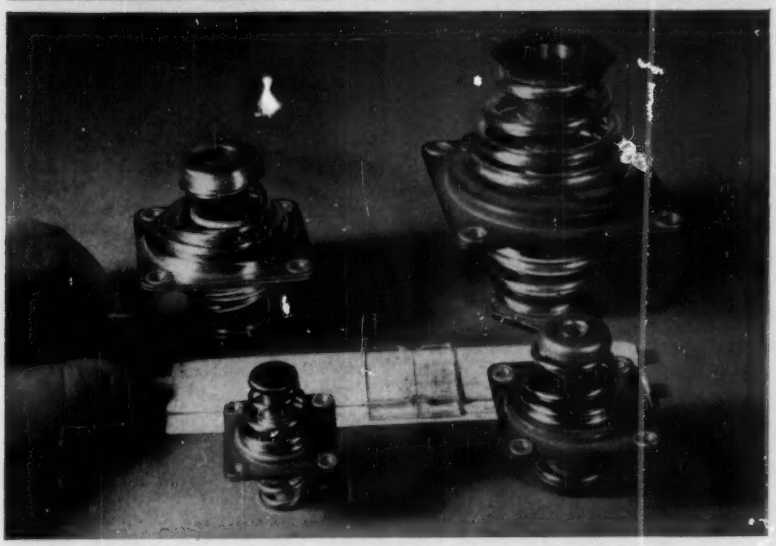


MB's Iso-Damp Spring Mount Now Available in 4 Sizes

combines low frequency damping with high frequency isolation

The unique vibration isolation characteristics of the MB Iso-Damp Spring Mount can now be applied to a wider range of applications with the recent design of 3 new sizes, covering a spring rate range of 14 lbs./in. to 500 lbs./in. and load capacities up to 50 lbs. per mount.

The Iso-Damp principle combines low frequency damping with high frequency isolation. Damping is provided in all three directions through friction obtained from sliding contact between brake lining material and metal surfaces. Sufficient damping is provided to limit magnification at resonance to 5 to 1 at low input amplitudes and to much lower magnification levels at higher inputs.

The unique damper design results in equal and controlled damping in any direction of vibration excitation. Damping elements are amplitude sensitive so that friction damping occurs only in the region of resonance. Above this region the damping elements become inoperative, thus permitting maximum isolation.

MB Iso-Damp Spring Mounts are constructed of materials chosen for their thermal stability, as well as their isolation and damping characteristics. The mounts will perform at continuous operating temperatures from −100°F to 500°F.

The Iso-Damp unit will withstand high shock loads without mechanical failure or impairment of performance characteristics. The interlocked design of metal parts assures that the equipment will be "failsafe" under even more severe shock conditions.

Write for Mount Catalog to Isomode Division, MB Electronics, P.O. Box 1825, New Haven 8, Conn.

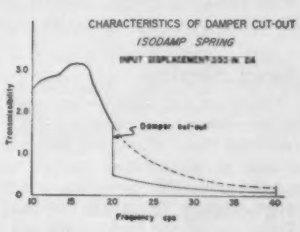
The Importance of Damping in Isolation

Although damping is primarily the concern of the isolator designer, the equipment designer would be well advised to know something about the effect of damping on the overall isolation of his system. Even in the best environment some damping is necessary. There are always instances when the forcing frequencies correspond to the natural frequencies of the system. Without damping, magnification of amplitude and forces due to resonance would result, causing damage to the equipment or the isolator.

While damping will reduce the amount of magnification due to resonance, it can also produce undesirable side effects. The best way to isolate is to avoid restraining a deflection. Damping involves restraint, resulting in the transmission of unwanted displacements or forces through the isolator. Consequently, in the region where the isolator is cushioning the forces or deflections it is not as effective as it could be without damping. However, in the region where the isolator is "bobbling" at its natural frequency damping prevents the "bobble" from becoming destructive.

There are three basic types of damping, each having its advantages for particular applications: 1. Solid damping or hysteresis damping, such as provided by rubber; 2. Viscous damping, such as a dashpot; and 3. Dry friction or coulomb damping, characterized by the Isodamp spring mount.

The curve below indicates how the Isodamp unit applies friction damping in the region of resonance and cuts out at higher frequencies to permit maximum isolation.



Circle 289 on Page 19

Foam Products

Two charts show properties and uses of standard foam products. Tabulation of dielectric and physical properties of artificial and adjusted dielectric constant foams is presented. Electrical and physical properties are tabulated separately. Foam sheets, both rigid and flexible, as well as a number of foam-in-place and pack-in-place synthetic foams, are described. 12 pages. Emerson & Cuming Inc., 59 Walpole St., Canton, Mass.

Circle 416 on Page 19

Rod Ends; Spherical Bearings

Features expanded line of Alinabal rod ends and spherical bearings. Discusses types of units, including large-size rod ends and control-rod assemblies. Points out construction features, gives dimensions and specifications. Catalog 102, 12 pages. Split Ballbearing Div., Miniature Precision Bearings Inc., Lebanon, N. H.

Circle 417 on Page 19

Air Power Cylinder

Describes 200 psi, Series C air power cylinder. Catalogs both single and double rod-end units in five bore sizes from 1¼ to 4½ in. Discusses use of floating cushions in applications involving fast stroke or high shock conditions. Bulletin 0220-B1, 4 pages. Dept. 116, Hannifin Co., Div., Parker-Hannifin Corp., 501 S. Wolf Rd., Des Plaines, Ill.

Circle 418 on Page 19

Switching News

Issued at various intervals, "Uses Unlimited" provides switching news for the design engineer. Various new switches are described, and new or unusual uses for switches are covered. Vol. 13, No. 1, 8 pages. Micro Switch Div., Minneapolis-Honeywell Regulator Co., Freeport, Ill.

Circle 419 on Page 19

Teflon Data

Presents information on new uses for Teflon in various fields, material on standards, and other data. Published monthly. "Journal of Teflon," 8 pages. E. I. duPont de Nemours & Co. Inc., 2524 Nemours Bldg., Wilmington 98, Del.

Circle 420 on Page 19

Variable-Speed Belts

Contains tables of cross-reference for manufacturers of equipment using variable-speed belts, with manufacturer's belt part number given with Wood's comparable number. Bulletin 24103, 20 pages. T. B. Wood's Sons Co., Chambersburg, Pa.

Circle 421 on Page 19

Spray Nozzles

Illustrates and describes automatic pneumatic atomizing spray nozzles for industrial use. Basic design of the nozzles includes an air-actuated control valve for automatic nozzle operation synchronized with a given production or work cycle. Variations of the basic nozzle are shown, and a typical installation is schematically illustrated and described, along with accessory equipment normally used. Bulletin 114, 4 pages. Spraying Systems Co., 3274 Randolph St., Bellwood, Ill.

Circle 422 on Page 19

Photoelectric Control

Describes photoelectric control designed for any lighting application where extended time delay is not desired. QR control functions automatically to give precise control of any lighting circuit or of individual luminaires. Bulletin shows entire unit and individual components, gives physical dimensions, electrical characteristics, and operating information. Bulletin GEA-7230, 6 pages. General Electric Co., Schenectady 5, N. Y.

Circle 423 on Page 19

Precision Casting

Describes plaster-mold casting and planar-investment casting, showing how both processes can be combined to overcome the limitations of either process alone. Typical castings of the three types are shown. Engineering table gives specifications and properties of eight nonferrous alloys. 18 pages. Atlantic Casting & Engineering Corp., 810 Bloomfield Ave., Clifton, N. J.

Circle 424 on Page 19

Pneumatic, Hydraulic Packings

Covers various types of packings—cup, flange, U, Vee, O-rings, back-up washers, one-piece double-acting piston cups, and double-lip shaft-wiper seals. Also includes information on materials, conditions of operation, typical design application, specifications, and data charts on packings in standard sizes. Bulletin 341, 16 pages. Chicago-Allis Mfg. Corp., 125 N. Green St., Chicago 7, Ill.

Circle 425 on Page 19

AC Motor-Run Capacitors

Includes general information, standard ratings, capacitor life data, capacitance tolerance, power factor, frequency, voltage tests, and a capacitance-temperature relationship graph. Also contains a table of capacities, physical dimensions, and product catalog numbers, as well as listing construction features and accessories. Catalog 171 Bl.1, 4 pages. New Bedford Div., Aerovox Corp., New Bedford, Mass.

Circle 426 on Page 19

Control Equipment

Illustrates and gives brief descriptions of high-performance feedback control hardware. Includes operational amplifiers, frequency-response test equipment, slide rules, pressure transmitters and receivers, actuators, programmers, and computers. 6 pages. Boonshaft Fuchs Inc., Hatboro Industrial Park, Hatboro, Pa.

Circle 427 on Page 19

Jewel Bearings, Assemblies

Gives information on properties and types of jewels and precision metal parts, characteristics of jewel bearings, types of jewel assemblies, settings, and selection factors. It also covers possible industrial applications in the precision-instrumentation field. 8 pages. Moser Jewel Co., 544 Fayette St., Perth Amboy, N. J.

Circle 428 on Page 19

Semiconductor Products

Covers germanium transistors, silicon transistors, diodes and rectifiers, solid-tantalum capacitors, materials and sensors, carbon-film and silicon resistors, and semiconductor networks. Includes three-page illustrated table of case outlines. Form TC 1704, 26 pages. Texas Instruments Inc., P. O. Box 5012, Dallas 22, Tex.

Circle 429 on Page 19

Quick-Disconnect Couplers

Open-Flow couplers with ¼ through 2-in. capacities are for working pressures to 6000 psi. Bulletin provides performance data, dimensions, weights, and designations. Catalog Sheet L-6104-2, 4 pages. Bruning Co., 601 S. Ninth St., Lincoln, Nebr.

Circle 430 on Page 19

Sleeve Bearings and Bars

Pictures custom-designed and standard stock sleeve bearing and bar-stock line. In addition to illustrations, bulletin carries general descriptive and specification information on the bearings and bars, available in various materials and combinations of materials. Bulletin JBL-35, 4 pages. Johnson Bronze Co., New Castle, Pa.

Circle 431 on Page 19

Heat-Transfer Data

Discusses Panelcoil uses in various applications, shows types of single and double-embossed units, and gives size data. Includes information on heat-transfer factors, selection of heating surface, how to determine heat-up surface area, figuring heating load, and typical load computations. Technical Data Bulletin 356, 26 pages. Dean Products, Inc., 1042 Dean St., Brooklyn 38, N. Y.

Circle 432 on Page 19

Copper-Nickel Alloy

Describes the properties, characteristics, and possible applications of Neutroloy ultrafine wire, essentially a copper-nickel alloy used in precision instrumentation. Covers resistance and weight, physical characteristics, resistance change versus temperature, and other details. Also discusses briefly other copper-nickel alloys. 4 pages. Molecu Wire Corp., Eastontown-Freehold Pike, Scobeyville, N. J.

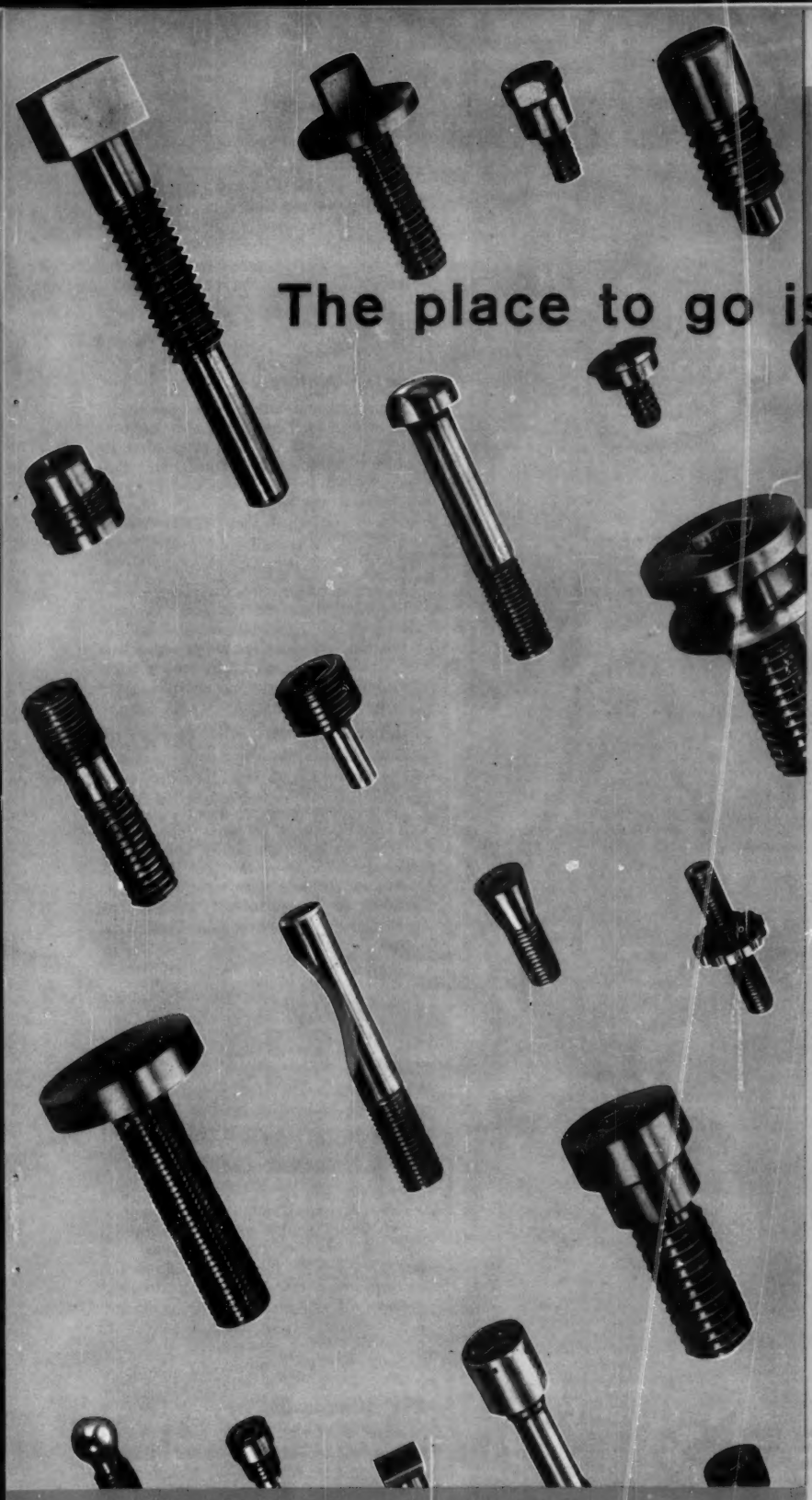
Circle 433 on Page 19

Centrifugal Pumps

Capacities of split-case centrifugal pumps range up to 6000 gpm, heads to 380 ft. Bulletin illustrates and describes the line of single-stage, double-suction, horizontal units, providing sectional photos, selection charts, dimensional data, limitations chart, and specifications. Bulletin 105C, 8 pages. Aurora Pump Div., New York Air Brake Co., Aurora, Ill.

Circle 434 on Page 19

Circle 290 on Page 19→



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produced in large or small quantities

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Mac-it Fastener Engineering Service will give you practical and professional assistance in developing any type of threaded fastener.

Unusual head or thread designs, unusual materials, unusual shapes —these are some of the unusual characteristics of Mac-it specials. But whatever you want, you'll find a personal, interested service group at Mac-it that is ready and able to match your requirements exactly.

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Wherever pressure and vacuum sealing electrical leads is a problem, consult CONAX. They provide a complete line of electrode glands answering a wide range of problems. Standard designs have a recommended 2000 RMS voltage rating with an amperage range from 3.0 to 200 amps. On request, CONAX modern laboratories (capable of testing from .005 micron absolute to 10,000 psi liquid or gas pressure and voltage to 2000 volts. A. C.) will certify electrode glands for higher pressures and voltages than the standards specified above . . . leakage rate data also available. CONAX engineers welcome the opportunity to help meet your special requirements.

For complete information write for Electrode Gland Catalog No. 960, Mineral Insulated Thermocouple Catalog No. 300 (Standard Assemblies available for 24 hour delivery, Catalog No. 2400), Thermocouple Assembly and Pressure Sealing Gland Catalog No. 1890 and Explosive Actuated Products Catalog No. 5808-XV.

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HELPFUL LITERATURE

Ball Valves

Provides selection data for Econ-O-Miser ball valves. Five types of pipe ends which can be used with the units are shown. Cost comparison between a standard ball valve, a standard gate valve, and the Econ-O-Miser is also included. 4 pages. Worcester Valve Co. Inc., 16 Parker St., Worcester, Mass.

Circle 435 on Page 19

Electric Motors

Covers line of standard and special motors in fractional and integral-horsepower sizes. Points out features, gives complete specifications and dimensional data. Bulletin 150, 14 pages. Doerr Electric Corp., Cedarburg, Wis.

Circle 436 on Page 19

Oilers, Controls, Lubricators

Describes bottle oilers for plain bearing lubrication, constant oil-level controls, glass-body oil cups, bronze oil cups. Information includes dimensions, oil capacities, installation techniques, and application methods covering a wide range of bearing lubrications. Circular 580, 4 pages. Lunkenheimer Co., Cincinnati 14, Ohio.

Circle 437 on Page 19

Wiring Conduit

Covers four types of Sealtite flexible, liquid-tight wiring conduit. Includes diameters, weights, and other specification information, and points out advantages and uses of each type. Bulletin S-544, 4 pages. Anaconda Metal Hose Div., Anaconda American Brass Co., Waterbury, Conn.

Circle 438 on Page 19

Solenoid Valves

Describes new two, three, and four-way units. Lists features, dimensions, general description, and operation for each unit. "Condensed Valve Supplement," 16 pages. Automatic Switch Co., Florham Park, N. J.

Circle 439 on Page 19

Quick-Disconnect Couplings

Provides simplified selection of quick connect-disconnect couplings for particular applications. Lists more than 575 fluids and gases, pointing out the types of seals to be used with these fluids at various temperature limits. Included are working pressures, flow, pressure drop, and spillage data on each product. Catalog 60A, 62 pages. Write on company letterhead to Snap-Tite Inc., Union City, Pa.

RTV Silicone Rubber

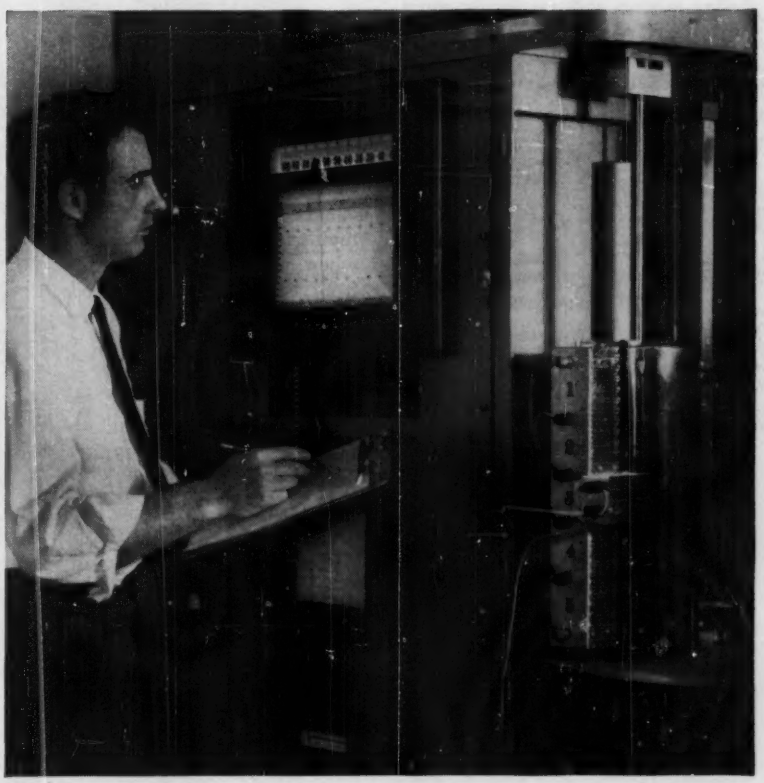
Provides details on the use of room-temperature vulcanizing liquid silicone rubber as a mold material. Includes section on special techniques, including the use of pressure casting for the reproduction of finely detailed parts. Also incorporates a measuring guide for mixing catalyst with the RTV materials. Catalog CDS-191, 8 pages. Write on company letterhead to Silicone Products Dept., General Electric Co., Waterford, N. Y.

One in a series of technical reports by Bower

BEARING BRIEFINGS

TESTING PUTS THE HEAT ON—HELPS BEARINGS BEHAVE IN EXTREME ENVIRONMENTS

In industry today, bearing operating conditions are becoming increasingly severe. To conquer difficult environments, heat, corrosion and oxidation, Bower conducts exhaustive research to achieve improved bearing performance. One important area of Bower research, for example, is the development of special alloys to withstand extreme heat. To do this, Bower researchers use special heating apparatus to study hardness, strength and other characteristics of alloys at temperatures in excess of 1000°F.



Bower engineers study how alloys stretch as temperatures rise in excess of 1000°F., to perfect bearings that can take it.

One of the devices Bower utilizes to assure bearing precision at high temperatures is a creep tester. Bower engineers use it to load a test bar to a predetermined stress level, then, with the assistance of a special heating unit, find out precisely how much the bar stretches as temperatures are elevated to a thousand degrees F., and beyond.

With this type of data and the help of other Bower precision research equipment, engineers can determine alloys that best withstand torrid temperatures. They can also effectively mate thermal expansion characteristics of the various alloys used in roller bearing components and in shafts and housings as well. As a result of this mating, Bower creates bearings that maintain precision in the required temperature ranges and ensures bearings that provide long life, heavy load capacity and high-speed operation.

Because of Bower's continuing research in bearing alloys and other critical areas, we suggest you consider Bower to assist you with your bearing needs. Bower provides a full range of types and sizes in tapered and cylindrical roller bearings as well as in journal roller assemblies. Bower Roller Bearing Division, Detroit 14, Michigan.

BOWER ROLLER BEARINGS

tapered cylindrical journal

DIVISION OF FEDERAL-MOGUL-BOWER BEARINGS, INC.

Circle 292 on Page 19

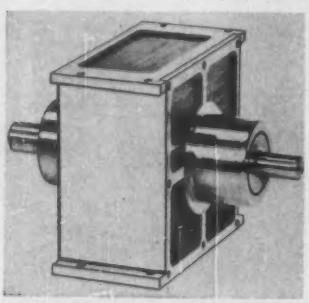
New Parts and Materials

Use Yellow Card, page 19, to obtain more information

Intermittent-Drive Unit

has smooth accelerating and decelerating indexing motion

Warren drive is a mechanical unit which converts rotary power to precise intermittent motion. It has smooth accelerating-decelerating indexing motion with no abrupt starts or stops. One frame size accommodates 34 models with 3 to 36 stations. Unit operates in any mounting position. It locks in dwell po-



sition with accuracy of ±0.001 in. measured on a 5-in. circle. Unit has positive locking at all stations with zero backlash. Torque rating is 80 lb-ft. Indexing and dwell time are both 180 deg. Unit provides high-speed indexing. **Precision Indexing Drives Inc.**, 2403 Fourth Ave., Tampa 5, Fla.

Circle 440 on Page 19

Fault Indicator

resists vibration from 10 to 500 cycles at 10g

New ¾-in., sealed, miniature, magnetic latch-in fault indicator is available in wide current and voltage ranges. Disc-type flag, which can be color-coded or imprinted to designate the function being monitored, rotates behind a sector window. When unenergized, flag is magnetically held in the off position. When

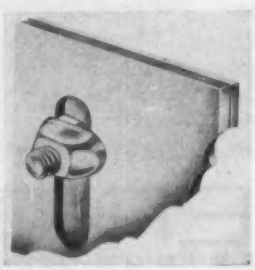
energized, it rotates to the on position and is held there magnetically even if the energizing source is removed. Return to off position is accomplished by reversing the polarity of the energizing source. Device maintains positive indication even when unenergized under vibration from 10 to 500 cycles at 10g. **Precision Meter Div., Minneapolis-Honeywell Regulator Co.**, Grenier Field, Manchester, N. H.

Circle 441 on Page 19

Quick-Release Fastener

is quarter-turn, all-nylon unit

Type NY-Q quarter-turn, quick-release fastener of one-piece molded nylon is a wedge or keystone shape. Base has ramp-shaped corners for easy tightening and pull up, and quarter-turn engagement is halted by stops molded into the central base of the fastener. Design is offered in No. 6, 8, and 10 sizes. Hole molded through the center of the



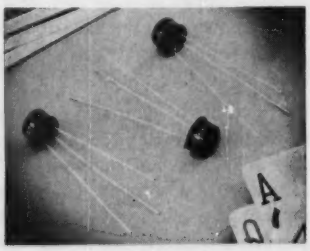
fastener is unthreaded and has an ID smaller than either a coarse or fine-threaded screw for a specific size. Sizes No. 6 and 8 accommodate sheet thicknesses from 0.050 in. up; No. 10 unit is for thicknesses from 0.060 in. up. Grip range is determined by the length of the screw selected by the user. Fastener can be used on curved surfaces where the radius is 4 in. or more. **Elastic Stop Nut Corp. of America**, 2330 Vauxhall Rd., Union, N. J.

Circle 442 on Page 19

Germanium Transistors

provide voltage ratings to 60 v

Three new germanium transistors, Types 2N1924, 2N1925, and 2N-1926, are for use in marginal high-voltage circuit designs. In addition to voltage ratings to 60 v, transistors have a high gain characteristic. They can be used in audio-frequency switching circuits as well as high-



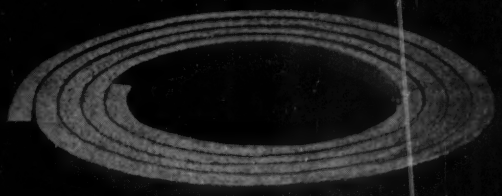
voltage amplifier circuits. **General Electric Co.**, Kelley Building, Liverpool, N. Y.

Circle 443 on Page 19

Bleeder Valve

for high-pressure hydraulic-system use

Zero-leakage (internal and external) stainless-steel bleeder valve for



J-M CHEMPAC 2009 PACKING

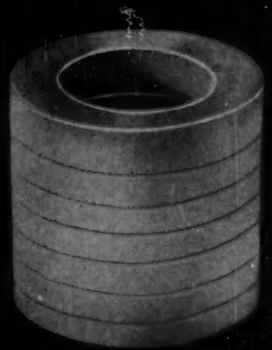
This all-purpose packing provides low-friction sealing, effectively resists heat and chemicals. Asbestos yarns are braided solid, cannot ravel or come apart.

J-M CHEMPAC TEFLON ENVELOPE STYLE GASKETS

These gaskets have proved highly satisfactory in glass-lined equipment. The filler is protected against active chemicals and solvents by an envelope of pure Teflon.

J-M CHEMPAC SPIROTALLIC® FLANGE GASKETS

These highly resilient gaskets maintain a tight seal, and compensate for varying stresses and temperature changes.



J-M CHEMPAC V-RINGS

The unique design of these molded packings assures superior performance... low friction ... operational and dimensional stability.

Where service conditions are severe...

...JOHNS-MANVILLE CHEMPAC® PACKINGS AND GASKETS SEAL BETTER, LAST LONGER, RESIST CHEMICALS AND SOLVENTS

Chempac is the Johns-Manville trade name for a broad range of J-M materials which combine the excellent sealing and heat-resistant qualities of asbestos...with the immunity of Teflon* to almost all chemical and solvent action.

Because these J-M packings and gaskets provide such long, efficient and economical service, they are preferred by many producers of chemicals, petrochemicals, petroleum products, and foods. They also serve in critical missile and aircraft applications, in automobiles and in many electrical and electronic units.

If you need outstanding performance under virtually any severe service conditions, rely on J-M Chempac products. Your J-M Representative will be glad to help you select the correct style for your equipment and service requirements. Or, write to Johns-Manville, Box 359, New York 16, N.Y. In Canada: Port Credit, Ont.

JOHNS-MANVILLE

JOHNS-MANVILLE JM PRODUCTS

*DU PONT TRADEMARK FOR ITS TETRAFLUOROETHYLENE RESIN.

New "Taylorite"® is a veritable workhorse

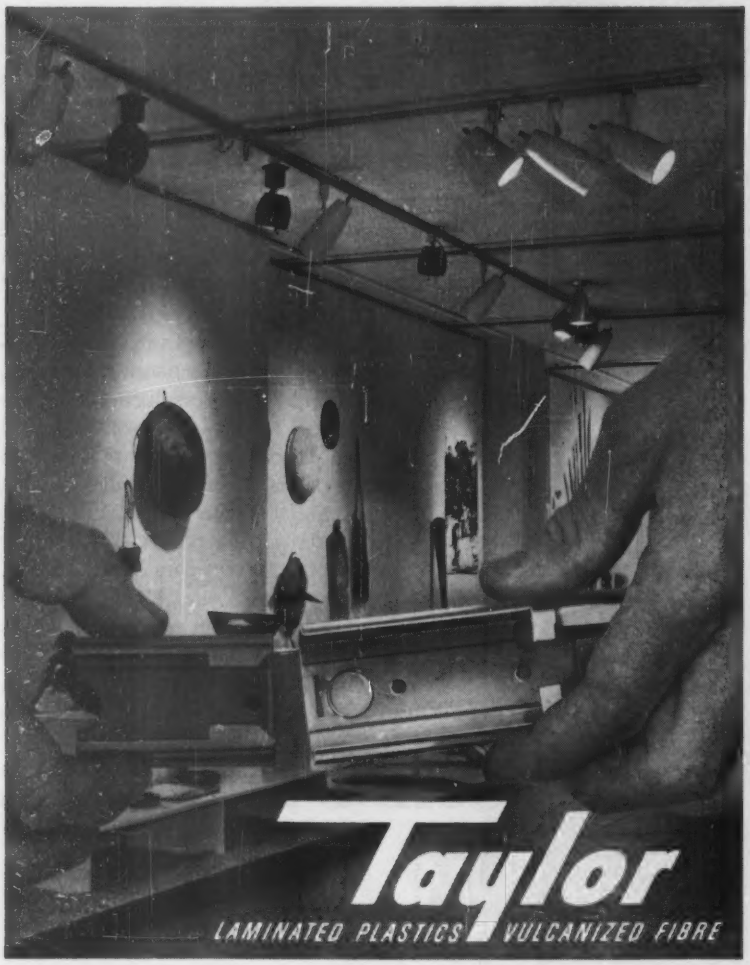
Improved Vulcanized Fibre... superior insulation, excellent forming characteristics

Dramatic highlighting of displays at the Philadelphia Commercial Museum is accomplished quickly and inexpensively with BullDog Universal Lighting Duct. Fixtures can be added, moved and relocated anywhere along the duct run in a matter of minutes. Contributing to the effectiveness and safety of this modern lighting system is the formed Taylorite vulcanized fibre part used to insulate the conductors from the end caps. Taylorite was selected because it provides superior insulation, has excellent forming characteristics, provides good dimensional stability. Taylorite is ideal for the fabrication of many mechanical components, too. Its high impact resistance, flexibility, formability, toughness and capacity to be deep drawn make it adaptable to 1001 industrial applications.

Samples are available. Test them for yourself. Put them under tension, flex them, compress them, form them. You will find that new Taylorite will pass your severest tests with flying colors. And remember, Taylor offers complete design and engineering assistance.

Write for Data Sheet 2-0 and samples. Taylor Fibre Co., Norristown 47, Pa.

Background photo courtesy Philadelphia Commercial Museum. Lighting Duct courtesy BullDog Electric Products Division, I-T-E Circuit Breaker Co.



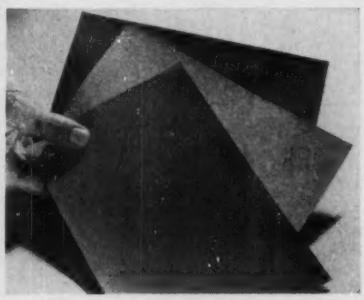
bleeding, sampling, or purging hydraulic systems while in operation is rated for system pressures to 3500 psi. Valve has a proof pressure of 7000 psi and a burst pressure of 14,000 psi. Having a width of 1 13/14 in. and a ¾-in. thick body, valve stands 1¼ in. above its mounting surface when installed. Knurled bleeder screw permits precise manual control of the discharge. Valve, which weighs 2.2 oz, is provided with a 7/16-20, UNF-3A threaded connection to facilitate mounting. Swivel mounting feature allows 360-deg positioning of the discharge nozzle for most convenient operation. **Fluid Regulators Corp.**, 313 Gillette St., Painesville, Ohio.

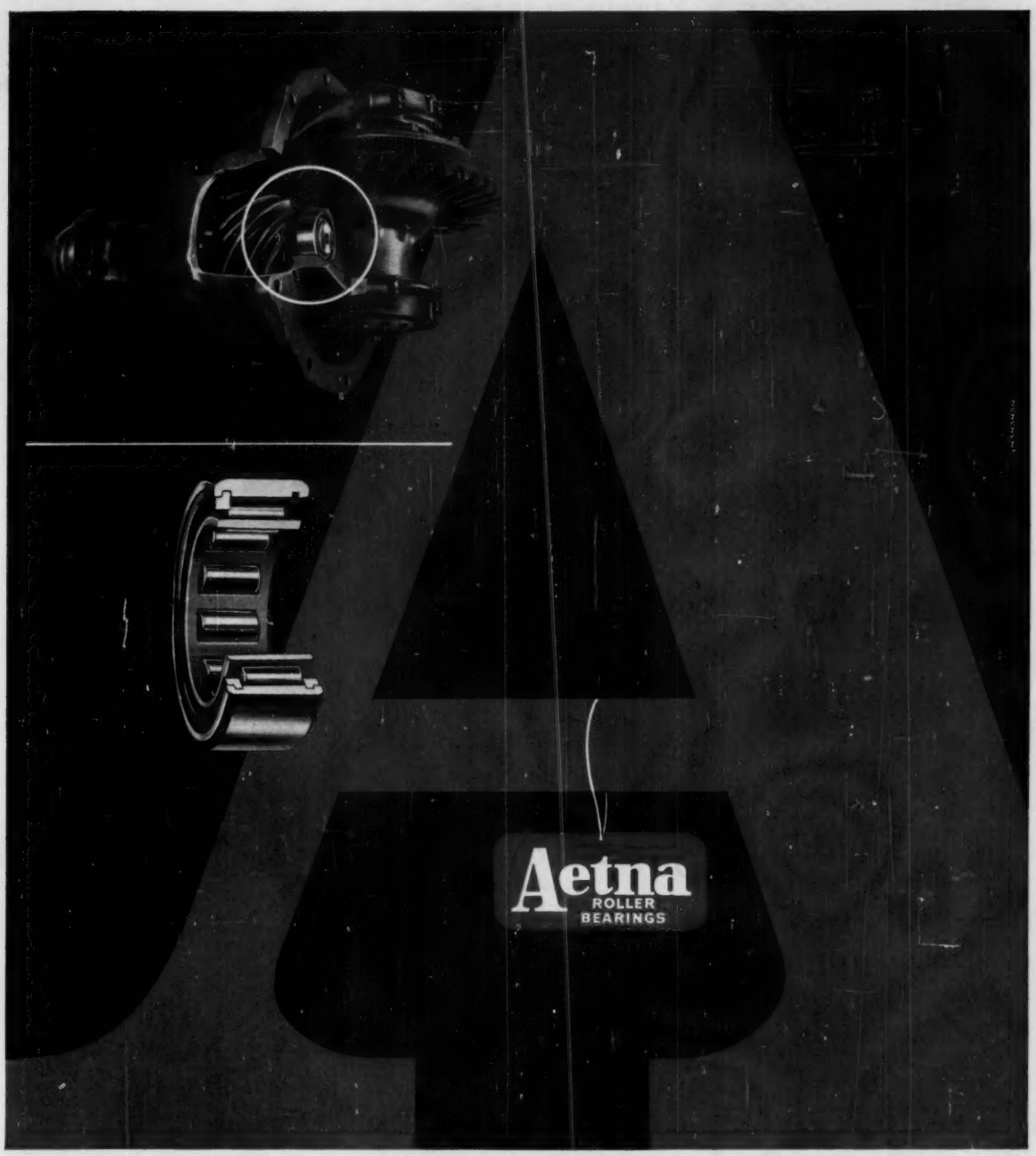
Circle 444 on Page 19

Vinyl Surfacing Material

for decorative use over metal, wood, subsurfaces

Decorlon vinyl surfacing material is flexible, easily bonded, durable, resistant to fading and to most stains. It is available for decorative-wear use over metal, wood, glass-fiber reinforced polyester, and other subsurfaces. Material has excellent dimensional stability, has a heavy vinyl face, is mold and mildew-resistant, and has a flame-spread rating of 20 when tested in accordance with ASTM E 84-59T. It is offered in three embossed textures, 20 colors, and two thicknesses, 0.030

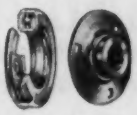




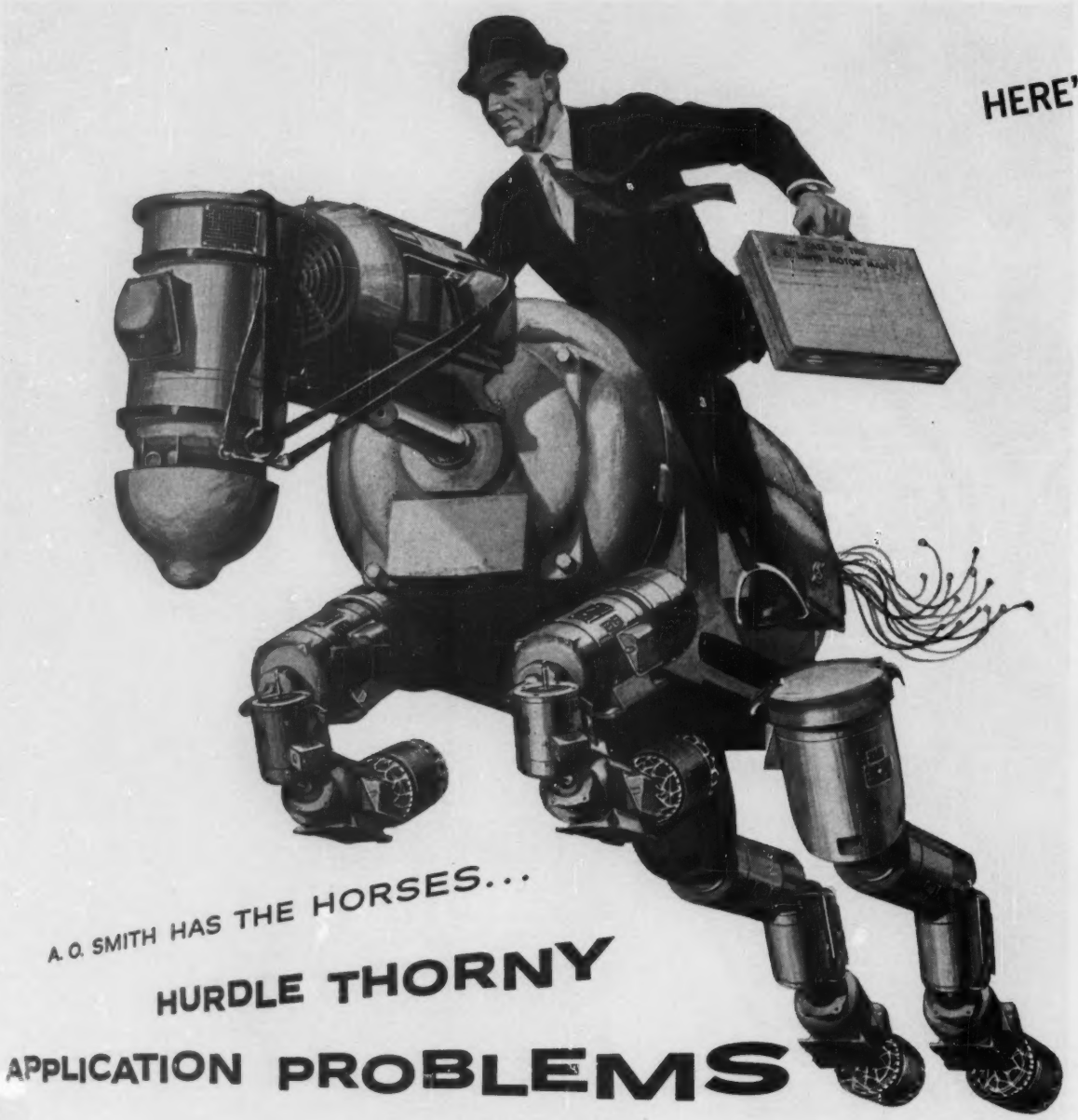
FOR FORD... QUALITY, THAT'S ALL For many years, Aetna bearings have been a part of Ford cars and trucks, helping to maintain their high standards of efficiency. In many Fords, Aetna roller bearings are a vital component in the differential. Clutch release bearings by Aetna also assure smooth transfer from low to high speeds. Apply this same anti-friction efficiency and quality to your product. Aetna bearings are available in a wide range of sizes in both roller and ball types, plus many special designs in both pure radial and pure thrust. For details, call your Aetna representative listed in your telephone directory or write for General Catalog and Engineering Manual.

AETNA BALL and ROLLER BEARING COMPANY
DIVISION OF PARKERSBURG-AETNA CORPORATION
4600 SCHUBERT AVE.
CHICAGO 39, ILL.

ANTI-FRICTION SUPPLIERS TO LEADING ORIGINAL EQUIPMENT MANUFACTURERS SINCE 1916



Circle 295 on Page 19



. . . a line of industry-wide favorites, built to make tough applications seem easy

When it comes to building electric motor-powered equipment, *make sure of your horsepower source.* Before you specify any motor brand, consult with your A. O. Smith Motor Man. He'll show you how the horses of A. O. Smith (a full line of integrals and fractionals both polyphase and single-phase) help users surmount application barriers.

And A. O. Smith delivers the horses that deliver the goods — 24-48 hour action on all parts and service orders.

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Through research . . . a better way

A.O.Smith
CORPORATION
ELECTRIC MOTORS
Tipp City, Ohio

A. O. SMITH INTERNATIONAL S. A.
Milwaukee 1, Wisconsin, U. S. A.

Circle 296 on Page 19

A CASE IN POINT

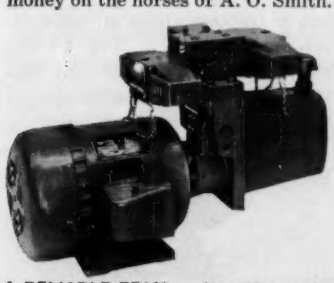
A TEAM THAT PULLS TOGETHER

Latest development in the industrial line of Vickers Inc. (Division of Sperry Rand Corporation) is its new PK line of motorized hydraulic power packages. These versatile units have a wide range of use on small machine tools, presses, paper machinery, textile machines plus countless other industrial applications.

Being "Jacks of all trades" PK power packs required a motor that would team up efficiently for all kinds of service—a motor that could operate on unusual applications yet still be custom-engineered for the particular job it had to do. Vickers had to be particular — that's why they chose A. O. Smith totally enclosed fan cooled motors.

A. O. Smith motors are current choices wherever a simple, compact, powerful unit is needed—in the case of Vickers PK, a motor built for years of reliable hydraulic power and control. Simple and compact because the entire package is close-coupled . . . with splined motor shaft for ease of assembly and disassembly. Reliable because of exclusive A. O. Smith TEFC features — die cast rotor, efficient cooling system, permanently lubricated bearings, reserve insulation protection.

You'll find it pays to team up with A. O. Smith motors — mechanically and electrically, you get more for your motor dollar when you put your money on the horses of A. O. Smith.



A RELIABLE TEAM — New Vickers PK motorized power pack powered by an A. O. Smith TEFC motor — a combination that runs without a hitch.

and 0.040 in. Material is available in lengths to 105 ft, 54 in. wide, and can be split to desired widths. **Industrial Div., Armstrong Cork Co.,** Lancaster, Pa.

Circle 445 on Page 19

Overrunning Clutches

provide torques from 5 to 500 lb-in.

Six stock sizes of clutches for overrunning, ratcheting, or preventing reverse rotation are now available. Hubs are heat-treated, tapered to minimize backlash, and dry-lubricated with a baked coating of resin-bonded molybdenum disulfide. Mating clutch hub is supplied by the user as an integral part of his

crank, gear, sheave, sprocket, or pulley. Hub can be of almost any material, including sintered metal or plastic. Chrome-vanadium-steel clutch springs are heat treated, and have a rectangular section to minimize wear. Stock bores are 1/8 to 5/8 in., and torques are 5 to 500 lb-in. **International-Mechanisms,** 2815 Baird Rd., Fairport, N. Y.

Circle 446 on Page 19

Angle-Type Counters

have torque levels down to 0.1 oz-in.

Mark II Series counters are angle units designed to suit a wide range of military and commercial applications. They provide continuous display from 0 to 359.9 deg for the same direction of shaft rotation, returning then to zero, or 0 through 359 deg. Equipped with Geneva drives, counters are furnished with torque levels down to 0.1 oz-in. and speeds to 2500 rpm. Counter parts are stainless steel and housings are die-cast aluminum. Counters operate throughout a temperature range

NEW CORED FORGING METHOD

saves on parts and assemblies

This book describes the Bridgeport Cored Forging Process, and tells how weight, machining or assembly can be reduced on simple or complex parts.

Castings, ordinary forgings and assemblies have been economically replaced by these impact-type cored forgings to produce stronger and better looking finished parts. Savings range from significant to considerable.

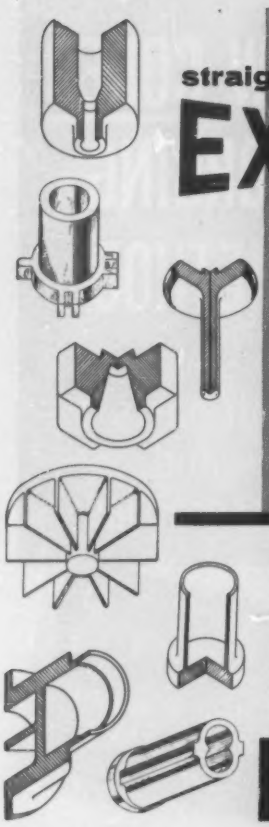
✓	closer tolerances
✓	denser, stronger grain
✓	less machining to finish
✓	no assembly required
✓	thinner walls or sections
✓	less finished weight
✓	multiple coring
✓	lower cost plating
✓	less scrap/rejects

Send for Bridgeport's Forgings Book which describes how these major benefits can lower costs for you.

CORED FORGINGS DIVISION
BRIDGEPORT
BRASS COMPANY
1000 Connecticut Ave., South Norwalk, Conn.

Circle 297 on Page 19

COPPER BASE ALLOY
straight and inverted
EXTRUSIONS



For complex metal shapes not obtainable by conventional processes.
offering:
- Flexibility of Design
- Close Tolerances
- High Production
- Reduced Machining Operations
- Elimination of Porosity
- Greater Uniformity
- Excellent Grain Refinement
- No Chip Loss

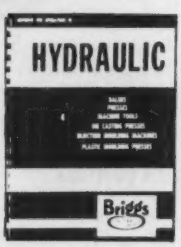
Janney is equipped to produce a wide variety of quality controlled complex metal shapes by advanced methods in all extrudable copper base alloy materials and such metals or alloys as beryllium copper, zinc, etc. Heat treating and machining performed where required. Sizes 1" to 8" diameter by 10 foot lengths in tubes and up to 12" diameters, 30" long in inverted extrusions. Write for Extrusion Bulletin.

JANNEY CYLINDER CO.
7427 State Road
Philadelphia, Pennsylvania

Circle 298 on Page 19

BRIGGS OFFERS YOU, FREE, A 12 PAGE MANUAL ON HYDRAULIC FLUID CIRCUITS AND HYDRAULIC OIL FILTRATION

HERE is a big 8½" x 11", file size, 12 page, fully illustrated booklet. It's brimful of technical data and drawings that every designer and operating engineer will want to read or keep for ready reference. Write for your copy. No obligation.



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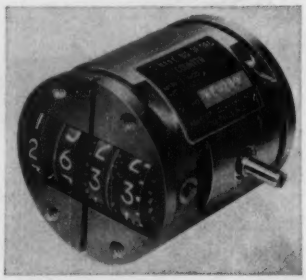
REPLACEMENT FILTER CARTRIDGES

THE BRIGGS FILTRATION CO., DEPT. 391, WASHINGTON 16, D. C.

YES AT NO COST OR OBLIGATION, SEND ME THE ABOVE HYDRAULIC MANUAL
NAME .....
COMPANY .....
ADDRESS .....

PRODUCT OF RESEARCH

Circle 299 on Page 19



of −65 to +90 C, and meet military requirements for shock, vibration, and case size. **Kearfott Div., General Precision Inc.**, 1150 McBride Ave., Little Falls, N. J.

Circle 447 on Page 19

Epoxy Adhesive

is conductive material

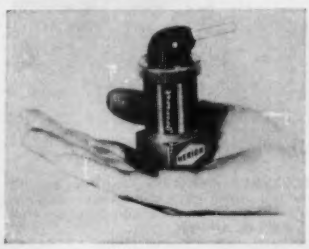
Conap 1225 is a conductive adhesive based on epoxy resins. It can be used with various hardeners to modify handling and operative characteristics. Material is filled with silver, and when cured yields a volume resistivity of 0.01 ohm-cm at 25 C. Water absorption after 24 hr is 0.1 per cent and shrinkage during cure is 0.15 per cent. Mixed material is a smooth, easy-to-apply paste. **Conap Inc.**, 184 E. Union St., Allegany, N. Y.

Circle 448 on Page 19

Slide Valve

midget solenoid unit is for pressures to 1400 psi

Small solenoid valve can be used as a two, three, or four-way unit; operation is based on the slide-valve principle. DC solenoids for either 6, 12, or 24 v with a power consumption of 5 w are available. Valve can be used in systems with up to 1400 psi working pressure. It has a response time of approximately 40 millisec. Size of the valve is 1.3 x 1.3 x 2.5 in., and

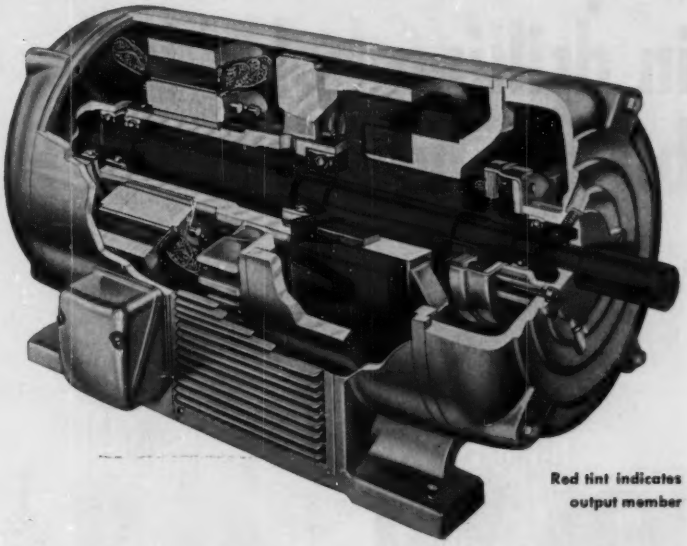


NOW— another FIRST by the Originator of Eddy-Current Equipment

NEW

DYNAMATIC®

Model 905 Ajusto-Spede® Drive



Red tint indicates output member

Extends Capacity Range to 15 HP in the Popular Quill-Type Design

The addition of the new model ACM-905 to the famous ACM-903 and ACM-904 lines of Dynamatic Ajusto-Spede Drives makes the desirable features of Dynamatic Quill-Type design available for many new applications.

Dynamatic Ajusto-Spede Drives provide controlled adjustable speed from an AC power source. Standard control features include on-off clutch control, infinite speed adjustment, constant speed regulation, and jogging. Any of a variety of special features may be easily and economically added to the standard control.

All Quill-Type models are available with either eddy-current, Dyna-torQ, or fail-safe brakes.

An Ajusto-Spede Drive, a control unit (either electron tube or transistorized magnetic amplifier), and a push-button station comprise a compact, easily installed, low-cost drive package.

Check these Ajusto-Spede® Advantages

- ★ **Infinitely adjustable speed from AC power**
- ★ **Simplified construction**
- ★ **Compact design**
- ★ **Wide speed range**
- ★ **Remote control**
- ★ **Stationary field coils**
- ★ **Excellent performance characteristics**

Send for Illustrated Descriptive Literature

EATON®

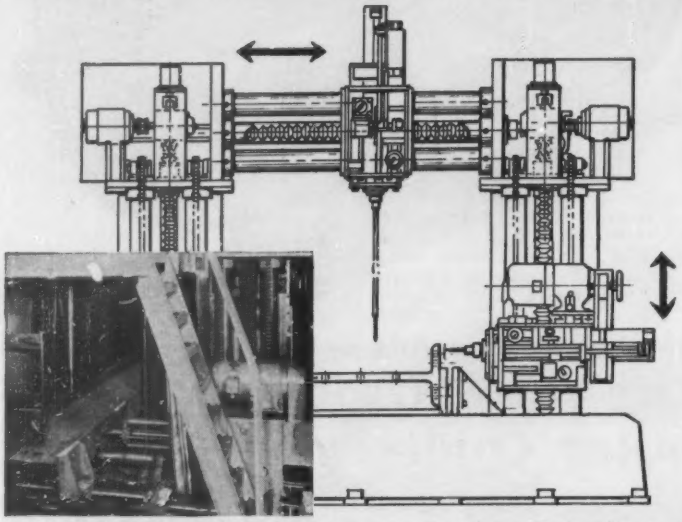
EATON DYNAMATIC DIVISION

MANUFACTURING COMPANY

3122 FOURTEENTH AVENUE • KENOSHA, WISCONSIN

Circle 300 on Page 19

Beaver Ball Screws help Mahon save 85% in drilling holes in bridge beams, columns



Close tolerance positioning of massive 1½" capacity vertical and horizontal drill heads is accomplished with Beaver ground-thread ball screws in this new, numerically controlled drilling machine, first in the structural steel industry.

Walter P. Hill, Inc., designed and built the machine for The R. C. Mahon Co., Structural Steel Division

In addition to the important drilling cost savings, it offers repeatability in hole pattern accuracy within ±.005" as compared with ±⅛" by conventional methods and eliminates costly hole reaming in final assembly.

If you are considering data control, Beaver ball screws will give you the power efficiency, positioning control and compactness you need. Our engineers will be glad to work with you just as they did, in this case, with the Walter P. Hill designers.

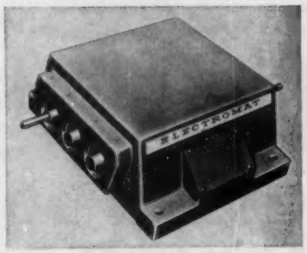
Beaver Precision Products INC.
CLAWSON, MICH.

weight is 30 oz. It is for ⅛-in. pipe size. **Herion Inc.**, Box 184, Valley Stream, N. Y.

Circle 449 on Page 19

Electric Gear Transmission

is available in horsepowers from 1 to 40



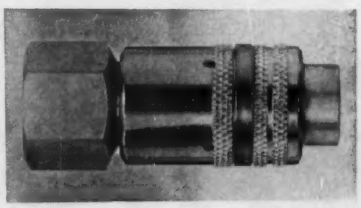
Electromat Mark I two-speed, electric geared transmission provides remotely controlled speed selection, torque control, and braking action. Speed selection is obtained through gear changes by means of high-response electric clutches operated in oil. Remote torque control is achieved by means of rheostats in the clutch and brake-control lines. Unit is available in horsepowers from 1 to 40 and speed ranges from 1:1 to 27:1. **Electromatic Inc.**, 4169 Pearl Rd., Cleveland 9, Ohio.

Circle 450 on Page 19

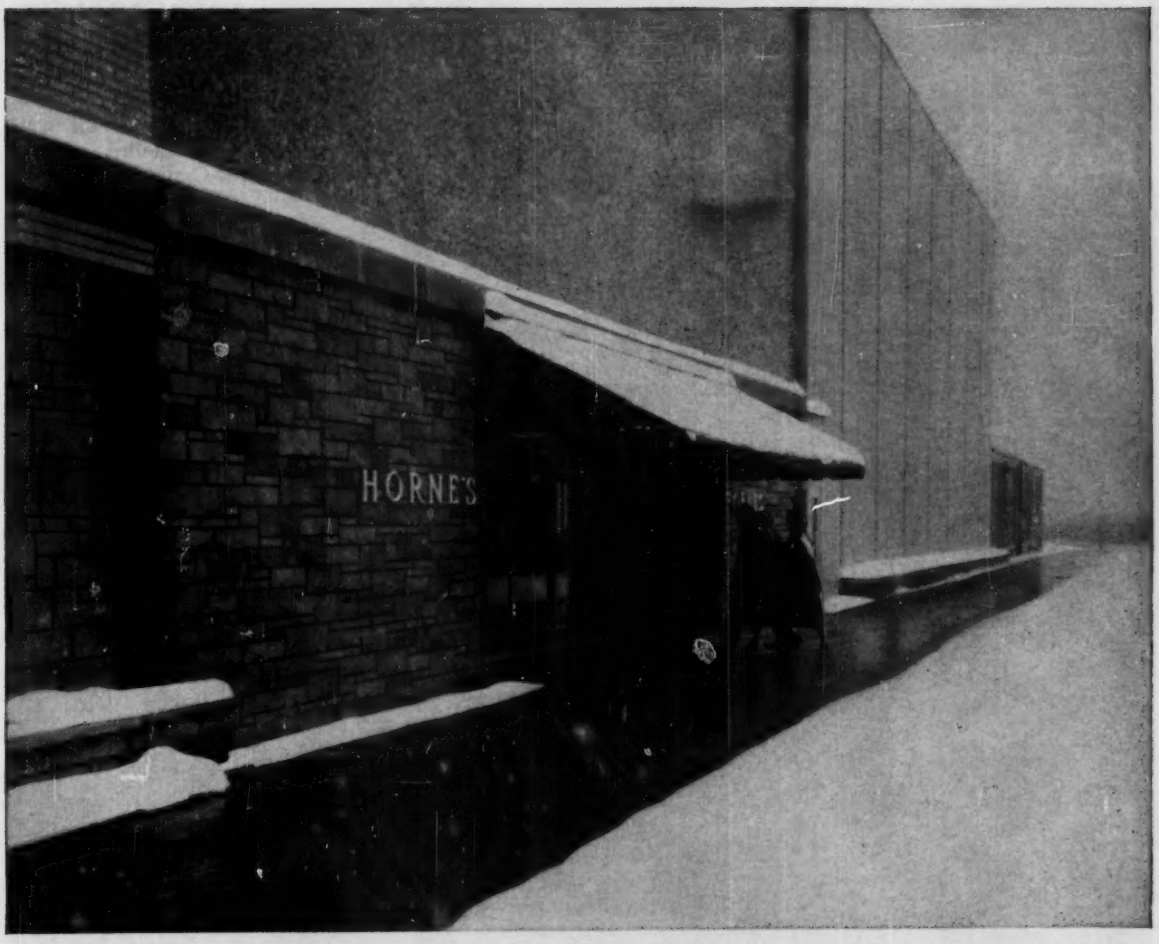
Pneumatic Couplings

are available in three new types

Dyna-Quip line of pneumatic couplings consist of three series—Dyna-Quip, Dyna-Matic, and Dyna-Con. Dyna-Quip ball type series is for limited quick-disconnect service. It has valves, valve springs, balls, and other components of stainless steel to prevent rusting. Dyna-Matic unit is an automatic pin-type coupling with a sleeve machined from one solid piece of bar stock. Hardened, stainless-steel pins rest against a hardened, stainless back-up ring. Dyna-Con is a high-ca-



Circle 301 on Page 19



This sidewalk is wired for snow

Nickel alloy electric heating cables in the concrete melt snow as fast as it falls!

No shoveling, no salting, no customer accidents on slippery sidewalks at *this* suburban branch of a Pittsburgh department store. Electric heating cables keep the sidewalks clear of snow and ice during even the worst winter weather.

Saves maintenance costs. In addition to taking the bother out of blizzards, the system eliminates the cost of conventional sidewalk clearance. And further savings are realized because the heating cables—made of 80% Nickel—require no maintenance.

High Nickel alloy cables were used because of Nickel's superior resistance to corrosion, fatigue and extreme temperatures. These Nickel alloy cables will withstand years of repeated heating and cooling, and seasonal expansion and contraction of the concrete.

Just one example of Nickel's versatility. Electric heating cables—also used to melt snow and ice from roofs and driveways—is another example of how Nickel helps make possible new products and processes, and improves existing ones. In most any application, Nickel's wide range of important properties . . . corrosion resistance, strength, long life and beauty, to name just a few . . . offers proven advantages.

If your business is metals, or if you use metals in your business, call on Inco for the latest information about how Nickel and its alloys can help you.

Imbedded near the concrete surface, electric heating cables of 80% Nickel keep the sidewalks clear of snow and ice. Cables made by Edwin L. Wiegand Company, Pittsburgh.

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street New York 5, N. Y.

INCO NICKEL

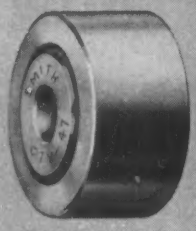
NICKEL MAKES ALLOYS PERFORM BETTER LONGER

SMITH

CAM FOLLOWERS AND YOKE ROLLERS

HCS CAM FOLLOWER

CTA CAM FOLLOWER



CTY YOKE ROLLER

Precision Made For Precise Performance

Each component of Smith Cam Followers and Yoke Rollers is carefully engineered, machined and finished to the most exacting standards and dimensions. As a result, each Standard Smith Cam Followers and Yoke Roller is identical to all others of the same series and size.

Such uniformity of product results in equal uniformity of performance

Standard Smith "CTA" (interchangeable) or "HCS" (High Capacity Stud) Cam Followers and "CTY" Yoke Rollers, assure you of outstanding performance with long, trouble-free life.

Special Smith Cam Followers and Yoke Rollers to suit special applications are supplied promptly.

Better distributors throughout the nation stock and sell Smith Cam Followers and Yoke Rollers.

Write for your new, quick reference data sheets.

SMITH BEARING DIVISION

Accurate Bushing Company

441 North Avenue, Garwood, New Jersey

Manufacturers of: Needle Bearings, Cam Followers, Yoke Rollers, Jet Engine After Burner Rollers and Bearing Assemblies, N. A. S. Standard and Special Bearings, High Temperature and Severe Wear Precision Parts.

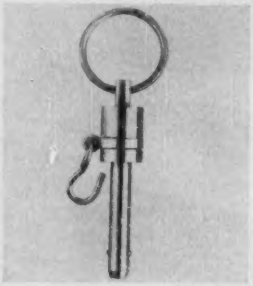
pacity combination coupling and valve to be used in any coupling application where automatic couplings are now installed. **Dyna-Quip Div., Stile-Craft Manufacturers Inc.**, 1825 Macklind Ave., St. Louis 10, Mo.

Circle 451 on Page 19

Quick-Release Pins

incorporate positive lock against accidental removal

Double-acting, quick-release pins are available in ring handle (shown), T-handle, and L-handle types. Stainless-steel balls projecting beyond the OD of the pins provide a positive lock against unintentional pin removal. Standard pins are



available in 17-4 PH and 4130 steel, and in either two or four-ball styles designed to NAS standards. Special handle configurations are available upon request. **Hartwell Corp.**, 9035 Venice Blvd., Los Angeles 34, Calif.

Circle 452 on Page 19

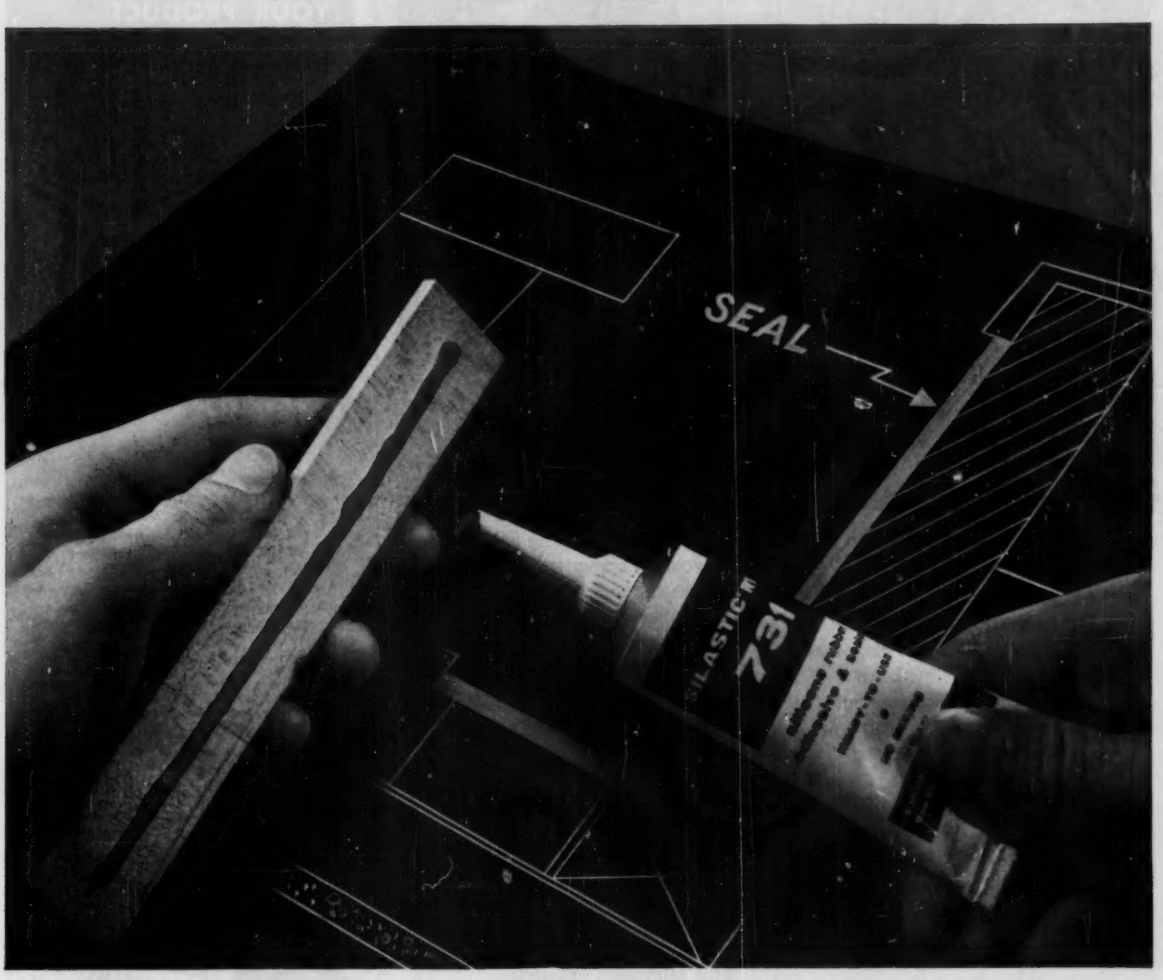
Edge-Reading Meter

can be stacked or easily assembled

Two models of a new edge-reading meter have no projections on the mechanism casing, permitting them to be stacked one on top of another and allowing simple attachment or removal from flush panel mountings. Model 12 is a miniature, null-type zero-center tuning indicator. Single-floating-coil movement provides reliability and ruggedness. Maximum length is 1¼ in. and maximum height is 9/16 in. Standard nulling ranges are from 500-0-500 mu amp to 3-0-3 ma. Model 13 reads both ac and dc ranges from 1 ma to 100 amp with accuracies of 3 to 5 per cent, depending

SILICONE NEWS from Dow Corning

Stops leaks permanently



New rubbery adhesive seals out moisture, dust, contaminants

Here's a really durable, silicone rubber sealant that sets-up at room temperature and bonds permanently to most materials, including metals and plastics. Silastic® RTV 731 has the easy-to-use consistency of toothpaste and is supplied ready for application in handy tubes.

Silastic RTV 731 flows out smoothly, clings to most materials, won't sag or slump when applied to vertical surfaces. It quickly sets-up on exposure to air and cures *without heat* to form a tough, flexible silicone rubber seal.

Seals made of Silastic RTV 731 show no loss of either adhesion or flexibility when exposed to low pressure steam, moisture, high humidity or corrosive atmospheres at temperatures ranging from —100 to 500 F. This sealant offers solutions to all types of sealing and bonding problems. Wherever your blueprints call for sealing, it will pay you to look into Silastic RTV 731.

Write for "Greater Versatility with Silastic RTV." Address Dept. 6921a, Dow Corning Corporation, Midland, Michigan.

first in silicones

Dow Corning

Electronic Talyvel

checks level to distance of 300 feet

"New Generation" Leveling

The Talyvel is a precise, completely portable level, battery operated. An electronic displacement signal, transistor-amplified, is fed to a zero-center meter. The meter is scaled in both angular and linear measures to indicate exact tilt of level. The pointer comes to rest in about 1 second of time; repeatability is approximately 1 second of arc.

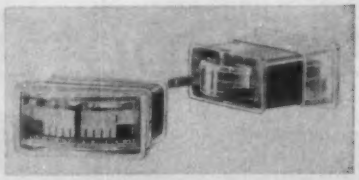
The Talyvel is designed for use in the many places where reading a block level is difficult. The instrument is particularly valuable for checking machine tools and launchers for missiles and rockets; for releveling and adjustment control.

For complete information, ask for Catalog TD-91

ENGIS EQUIPMENT COMPANY
431 S. DEARBORN ST.
CHICAGO 5 ILL. U.S.A.

Division of Engineering and Scientific Instrumentation

Circle 304 on Page 19



on range. Used as a voltmeter, ranges vary from 50 mv to 300 v. Maximum width is 1 13/16 in. and maximum height is ¾ in. **Electro-Mechanical Instrument Co.**, 8th & Chestnut Streets, Perkasie, Pa.

Circle 453 on Page 19

Laminated-Panel Adhesive

has operating temperature range from −32 to 200 F

Tygoweld 54 adhesive is a two-part, modified epoxy material used to bond either metallic or nonmetallic face materials to such core materials as Styrofoam, urethane foams, paper honeycomb, epoxy foams, glass-fiber bats, and wood. It has an operating temperature range of −32 to +200 F, with tensile-shear properties in the range of 1300 psi. Material can be applied either by conventional pressure-pot spray equipment or by high-volume, catalyst-mixing spray equipment. **Adhesives Div., United States Stoneware Co.**, P. O. Box 624, Stow, Ohio.

Circle 454 on Page 19

Lid Support, Hinge

for high-fidelity, radio and television cabinets

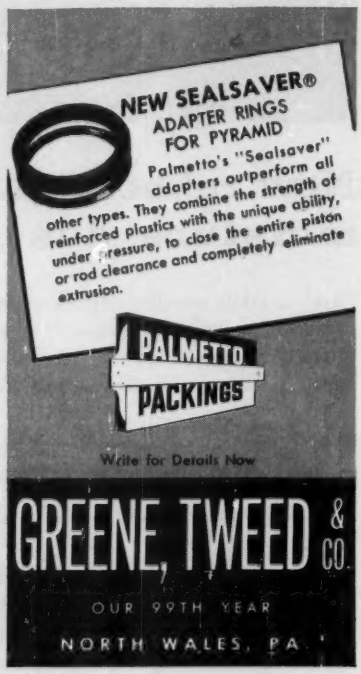
Self-balancing, combination lid support and hinge is available for high fidelity, radio, and television cabinets. Exterior application of the unit allows full use of the inside of the cabinet, eliminating interference with a phonograph turntable or similar equipment. Tension-adjustment screw provides flexibility to accommodate wide range of lid sizes and weights with the same spring. Hinge

maintains user preference for... YOUR PRODUCT

Palmetto® PYRAMID® V-PACKING

Pyramid protects the reputation of your hydraulic or pneumatic equipment with packing that gives long-lived, trouble-free service. Its advanced design remains dependably leak-free at all pressures; its proved construction features stronger walls and hinge area molded of endlessly folded fabric—which cannot fray and clog the hydraulic system. Pyramid rings have uniformly sharp sealing lips.

Curved lips and single lines of contact permit each ring to flex independently in response to pressure changes.


NEW SEALSAVER®
ADAPTER RINGS
FOR PYRAMID
Palmetto's "Sealsaver" adapters outperform all other types. They combine the strength of reinforced plastics with the unique ability, under pressure, to close the entire piston or rod clearance and completely eliminate extrusion.
PALMETTO PACKINGS
Write for Details Now
GREENE, TWEED & CO.
OUR 99TH YEAR
NORTH WALES, PA.

Circle 305 on Page 19

is steel in either brass-plate lacquered or statuary-bronze finishes. National Lock Co., Rockford, Ill.

Circle 455 on Page 19

Pressure Regulator

is 2¼ in. high and 1 7/16 in. wide

Banti-Reg pressure regulator is brass with a neoprene diaphragm. It is 2¼ in. high and 1 7/16 in. wide, and is available with or without a gage port. Both models are standard with ¼-in. NPT inlet and outlet, but ⅛-in. NPT connections are available. Primary pressures to 400 psi can be regulated to 5-125 psi secondary pressures. Unit delivers up to 80 cfm at 100 psi with 200 psi inlet pressure, ±1 per cent. Maximum operating temperature is 200 F. Wilkerson Corp., 1649 W. Mansfield, Englewood, Colo.

Circle 456 on Page 19

Fractional-Horsepower Motors

in sizes 12 and 15

AC and dc fractional-horsepower motors in sizes 12 and 15 are currently available in a number of variations. The ac motors are available in all types. DC configurations include permanent-magnet types, as well as series or shunt. Motors are supplied with optional brake, noise filter, thermal overload, and gear

(Please turn to Page 198)

unusual magnets for unusual applications

Shape is not the only unusual thing about these ceramic magnets! Most important is *how* and *where* they can be used. For *Ceramagnet*® is a basic, new design material — not a substitute for conventional metallic magnets. It allows magnetism to be creatively applied in new and better ways — usually at low cost — to literally hundreds of products from small motors, generators, coupling drives, holding devices, and filters, to lightning arrestors, sonar equipment, switches, and many others.

Ceramagnet permanent magnets are electrically non-conductive and chemically inert. They may be used without keepers and pole pieces, with many poles on one face, and under other conditions which would quickly demagnetize conventional magnets.

Where can Ceramagnet fit into your application? For ideas and technical data, send for Stackpole Bulletin RC-12A.

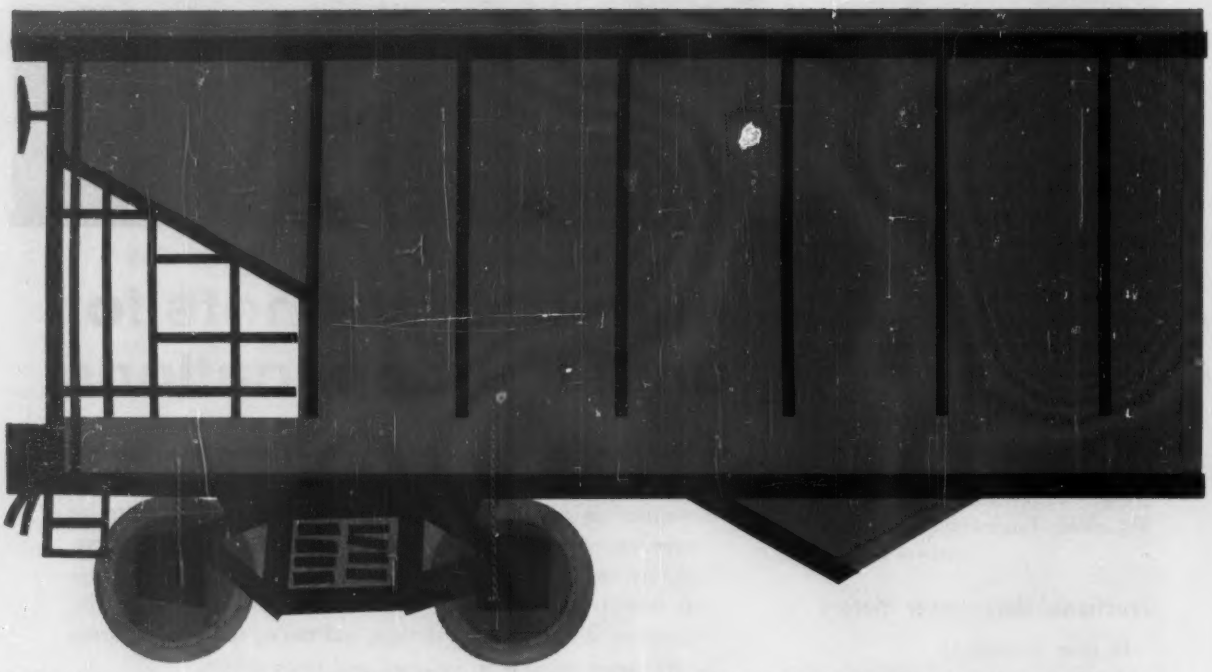
STACKPOLE CARBON COMPANY, St. Marys, Pa.

STACKPOLE *Ceramagnet*®

CERAMAG® FERROMAGNETIC CORES • SLIDE & SNAP SWITCHES • VARIABLE COMPOSITION RESISTORS • FIXED COMPOSITION CAPACITORS • BRUSHES FOR ALL ROTATING ELECTRICAL EQUIPMENT • ELECTRICAL CONTACTS • GRAPHITE BEARINGS & SEAL RINGS • COLDITE 70+® FIXED COMPOSITION RESISTORS • AND HUNDREDS OF RELATED PRODUCTS

Circle 306 on Page 19

How to design a 30% lighter body



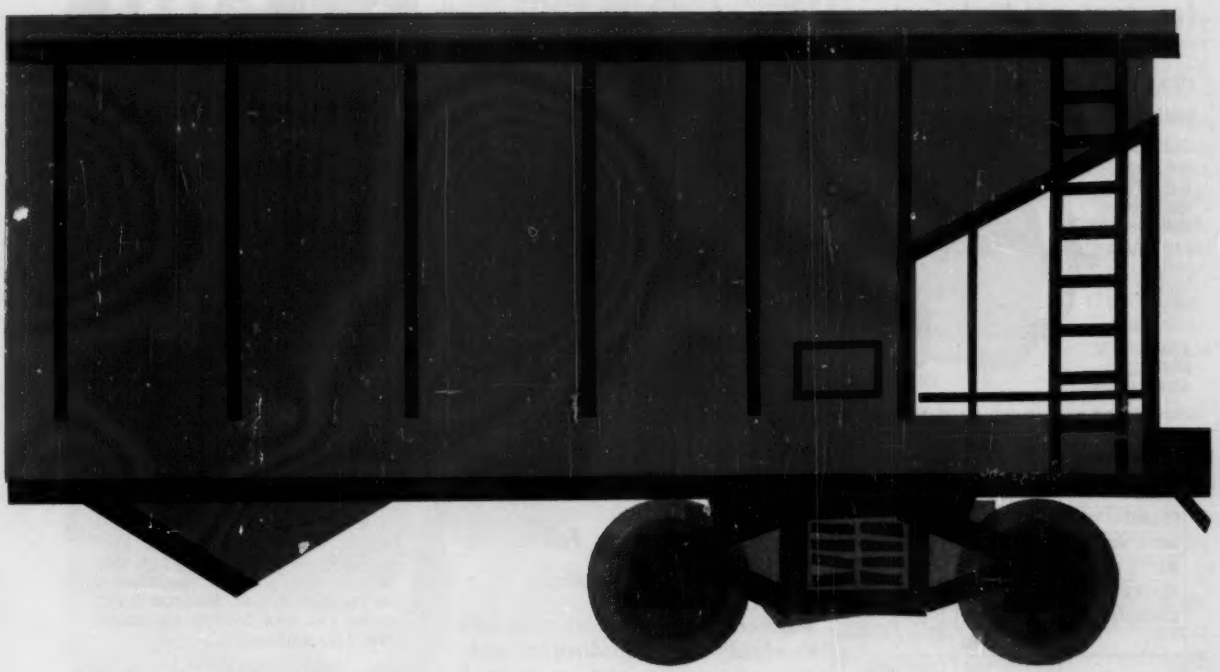
Here is a 70-ton hopper car that has yet to be built . . . but dramatic savings in weight at a nominal material cost can be made by designing it with USS "T-1" type A Constructional Alloy Steel Plate and USS Quenched and Tempered "T-1" type A Structural shapes now available.

Save 8,250 pounds of steel! A standard 70-ton capacity hopper car body fabricated in high-strength low-alloy steel and carbon steel plates and shapes normally weighs approximately 28,000 lbs. According to a special design study, the substitution of USS "T-1" type A Steel in certain components can result in a weight savings of about 8,250 lbs. The material cost for this design utilizing USS "T-1" type A plates and structurals, based on mid-1961 prices, is only $230 more than the present conventional hopper car. This means that a slight increase in the total cost of the steel itself can accomplish a significant weight reduction of 8,250 lbs.—nearly 30% of the existing body weight. Of greater importance is the potential 6% increase in over-all lading capacity realized through this savings in weight. Additional savings could be expected in hopper cars of greater capacity.

Greater payload offsets initial cost. Every pound of dead weight transported by a railroad is done so at the expense of a pound of potential payload per trip made during the life of a car. With

This mark tells you a product is made of modern, dependable Steel.

with USS "T-1" type A Steel



additional lading capacity, greater payloads possible would quickly offset the small additional steel cost involved. USS "T-1" type A Steel's minimum yield strength of 100,000 psi permits its use in thinner sections with accompanying weight reduction. Secondary benefits which accrue through the use of this exceptional constructional alloy steel include improved abrasion resistance, greater ability to withstand impact, and lower maintenance costs. All of these factors promote longer, economical service performance.

Our new quenched and tempered structural alloy shapes are now available in USS "T-1" and "T-1" type A Steels in the more commonly used sizes of wide flange (CB's) and American Standard beams, channels, equal angles and unequal angles.

For more information on USS "T-1" and "T-1" type A Steels, or on the new USS Quenched and Tempered Structural Shapes, write United States Steel, Room 6389, 525 William Penn Place, Pittsburgh 30, Pennsylvania. USS and "T-1" are registered trademarks.

United States Steel Corporation • Columbia-Geneva Steel Division • Tennessee Coal and Iron Division • United States Steel Supply Division • United States Steel Export Company

United States Steel USS

GENERAL INDUSTRIES

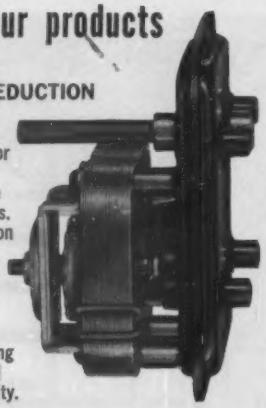
SMOOTH POWER

AC MOTORS

Assure plus performance for your products

GEAR REDUCTION MODEL

Designed for low speed, high torque applications. Molded nylon gears in a sealed housing insure extremely quiet running plus rugged dependability.



GENERAL SPECIFICATIONS

MODEL 205		
	Intermittent	Continuous
SPEED	13 RPM	13 RPM
TORQUE	150 in./oz.	100 in./oz.
AMPS, No Load	2.5	1.25
WATTS, No Load	26	13
REVERSIBLE	No	No
CONDENSER	None	None
MODEL 308		
	Intermittent	Continuous
SPEED	13 RPM	13 RPM
TORQUE	200 in./oz.	75 in./oz.
AMPS, No Load	1.2	0.4
WATTS, No Load	25	7
REVERSIBLE	Yes	Yes
CONDENSER	60 MFD	25 MFD

Above data based on 24 volts — Intermittent Duty 3 minutes on and 5 off. Both models can also be supplied for 115 volts — 60 cycles.

MOTORS FOR ALL TYPES OF APPLICATIONS

1/1800 to 1/35 H.P.

See Our Catalog in SWEETS 7a-Gen

or write for copy

Quantity Price Quotation On Request

THE GENERAL INDUSTRIES CO.

DEPARTMENT GK • ELYRIA, OHIO

Circle 307 on Page 19

(Continued from Page 195)

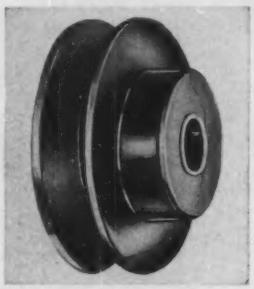
box. All can be qualified to military specifications. **Transco Products Inc.**, 12210 Nebraska Ave., Los Angeles 25, Calif.

Circle 457 on Page 19

V-Pulley Idlers

for A and B-section V-belts

Added to the Universal drive-tensioner line are bronze-bushed V-pulley idlers. Available in four different sizes for single-groove A and B-section V-belts, they are cast iron



and have a 1-in. bore. Also in the line are 14 sizes of flange flat pulleys and sprockets. **Brewer Machine & Gear Co.**, 1441-43 N. Second St., St. Louis 6, Mo.

Circle 458 on Page 19

Anodized Aluminum Foil

has wood-veneer finishes

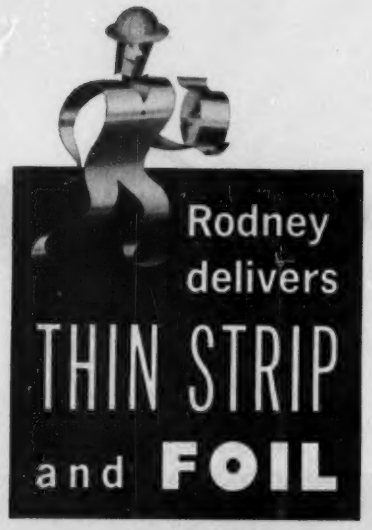
Anoveer pressure - sensitive - backed aluminum foil is anodized in multiple colors to simulate rare wood veneers. Material provides a wood-panelling effect for use in many applications. **Anodyne Inc.**, 1270 Northwest 165th St., North Miami Beach 69, Fla.

Circle 459 on Page 19

Quarter-Turn Fastener

for use in blind fastenings

One-piece, lightweight, spring-steel, quarter-turn fastener provides fast, simplified assembly and disassembly for blind fastenings. Fastener is inserted into prepared holes in panels, then locked and unlocked by pressing firmly with fingers and rotating 90 deg in either direction. Designated Part QA50080, fastener is self-re-



Precision Thinness in Stainless and Special Alloys...

Rodney concentrates its entire efforts, research and production, toward furnishing super thin, extra wide, precision rolled, metal strip and foil in all tempers and finishes. With the entire capacity of plant and personnel devoted exclusively to this specific area, Rodney can offer the added "know-how", manufacturing experience, quality control, and application knowledge your operation may require.

Rodney produces stainless steel strip . . . all alloys . . . in widths from ⅛" to 24" . . . at gauges from .012" to .0003". Rodney also rolls high temperature alloys and other special alloys on a production basis. Aluminum alloys, carbon steel strip and specialty custom rolling are also handled.

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Executive Offices:
261 Fifth Avenue, New York 16, N. Y.
West Coast Office & Warehouse:
5462 East Jillson St., Los Angeles 22, Calif.

Circle 308 on Page 19

OIL SEALS
in Design
Engineering

Garlock KLOZURE* Oil Seals stop oil leakage at bearings, increase efficiency of Denison Variable-Volume Hydraulic Pumps.

Denison designs hydraulic pumps around Garlock KLOZURE Oil Seals to assure maximum sealing efficiency.

Where pressures are too high for ordinary lip seals, KLOZURE Oil Seals prevent leakage of hydraulic oil and protect vital bearings as temperatures reach 150°F, pressures rise to 35 p.s.i., and shafts whirl at 1800 r.p.m. In use for the last twelve years, the seals have given complete satisfaction on the well-known line of axial piston and vane-type pumps made by Denison Engineering Division of American Brake Shoe Company.

Wherever bearings must have the best protection, Garlock KLOZURE Oil Seals are specified. On pumps like Denison . . . in steel mills . . . on power shovels and lift trucks . . . for motors, KLOZURE Oil Seals prevent leakage of lubrication, seal out harmful foreign matter. Whatever the application, there is KLOZURE Oil Seal to do the job. They are oil and grease resistant, impervious to mild acids and alkalies, non-abrasive, and will withstand temperatures from −40°F to +250°F. For extreme conditions, Garlock furnishes sealing elements resistant to practically any fluid, and serviceable as high as +500°F.

Availability is another prime reason for selecting Garlock KLOZURE Oil Seals. Once your design is finalized, you may select the proper seal from over 1800 stock items available from 180 national bearing distributors, including one near you.

It makes good sense to design with KLOZURE Oil Seals, as Denison and hundreds of other leading companies have found. See how you can benefit—call in your local Garlock representative. You will find him at the nearest of the 26 Garlock sales offices and warehouses throughout the U.S. and Canada. Or, write for Catalog AD-181. Garlock Inc., Palmyra, N. Y.

GARLOCK

Canadian Div.: Garlock of Canada Ltd.

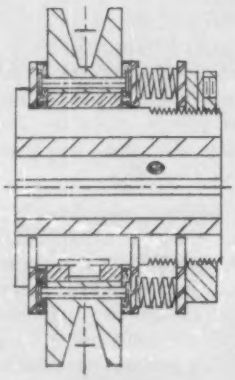
Plastics Div.: United States Gasket Company.

Order from the Garlock 2,000 . . . two thousand different styles of Packings, Gaskets, Seals, Molded and Extruded Rubber, Plastics Products.

*Registered Trademark

What some folks won't do to use a

CONWAY CLUTCH!



TORQUE LIMITERS, ANYONE?

YUP! IT FIGURES!

Q. Did you know that there is no known way to calculate the force exerted by a Belleville spring?
A. Yup!
Q. Did you know that *there is a way* to calculate the force exerted by a *coil spring?*
A. Yup!
Q. Did you know that if we don't know the force we can never calculate the torque?
A. Yup!
Q. Do you use CONWAY—the coil spring coil limiter?
A. Yup!

IT FIGURES!

Drop us a line . . get details . . get bulletins.

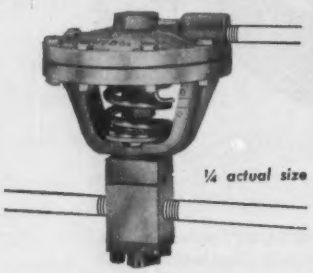
The CONWAY CLUTCH COMPANY

The World's Most Respected Name in Clutches for over a Half-Century
2750 COLERAIN AVE. CINCINNATI 25, OHIO

Circle 310 on Page 19

G. W. DAHL • G. W. DAHL • G. W. DAHL • G. W. DAHL • G. W. DAHL

POSITIVE CONTROL FOR PROBLEM FLUIDS!



¼ actual size

If suitable barstock material is available, any problem fluid can be throttled or provided with positive on-off control. Dahl BANTAM Control Valves, featuring barstock bodies, handle any chemical fluid except liquid metals like sodium and similar fluids where excessive temperature is a restriction.

BANTAM features include excellent flow characteristics, low hysteresis, and fast response. Offered in a wide selection of pneumatic operators and control positioners, standard models are rated at pressures up to 1000 psi at 450°F. Compactness, quality construction, and ruggedness also contribute to their virtually unlimited application versatility.

REQUEST Catalog B-1 for complete data on these versatile valves . . . for positive control of your problem fluids! G. W. Dahl Co., Inc., 83 Tupelo Street, Bristol, Rhode Island.

G. W. DAHL CO., INC.

SPECIALISTS IN COMPACT VALVES AND CONTROLS

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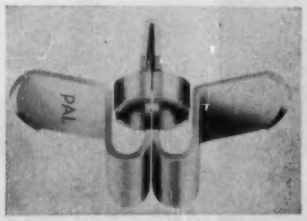
Circle 311 on Page 19



taining in the outer panel, avoiding displacement when assembly is opened. A barrel shank keeps fastener centered in hole. **Palnut Co., Div., United-Carr Fastener Corp.**, Glen Road, Mountainside, N. J.

Circle 460 on Page 19

Pressure-Sensitive Adhesive

has good heat resistance

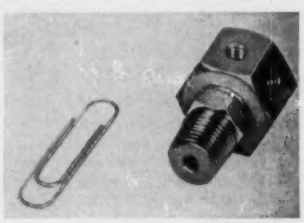
Bostik 2105 is a one-part, pressure-sensitive adhesive, designed for producing automotive, electrical, and similar tapes, which features high heat resistance. After cure, noncreep qualities and medium peel and shear strengths are achieved. The natural rubber-base adhesive, on Hycar saturated tape stock, adheres to metal and lacquered surfaces that need protection during painting and spraying operations, and maintains adherence through baking operations. Adhesive is recommended for producing pressure-sensitive tapes or stocks for any end usage that must resist high temperature for prolonged periods without lifting or creeping. It is applied by knife coating. **B. B. Chemical Co.**, 784 Memorial Drive, Cambridge, Mass.

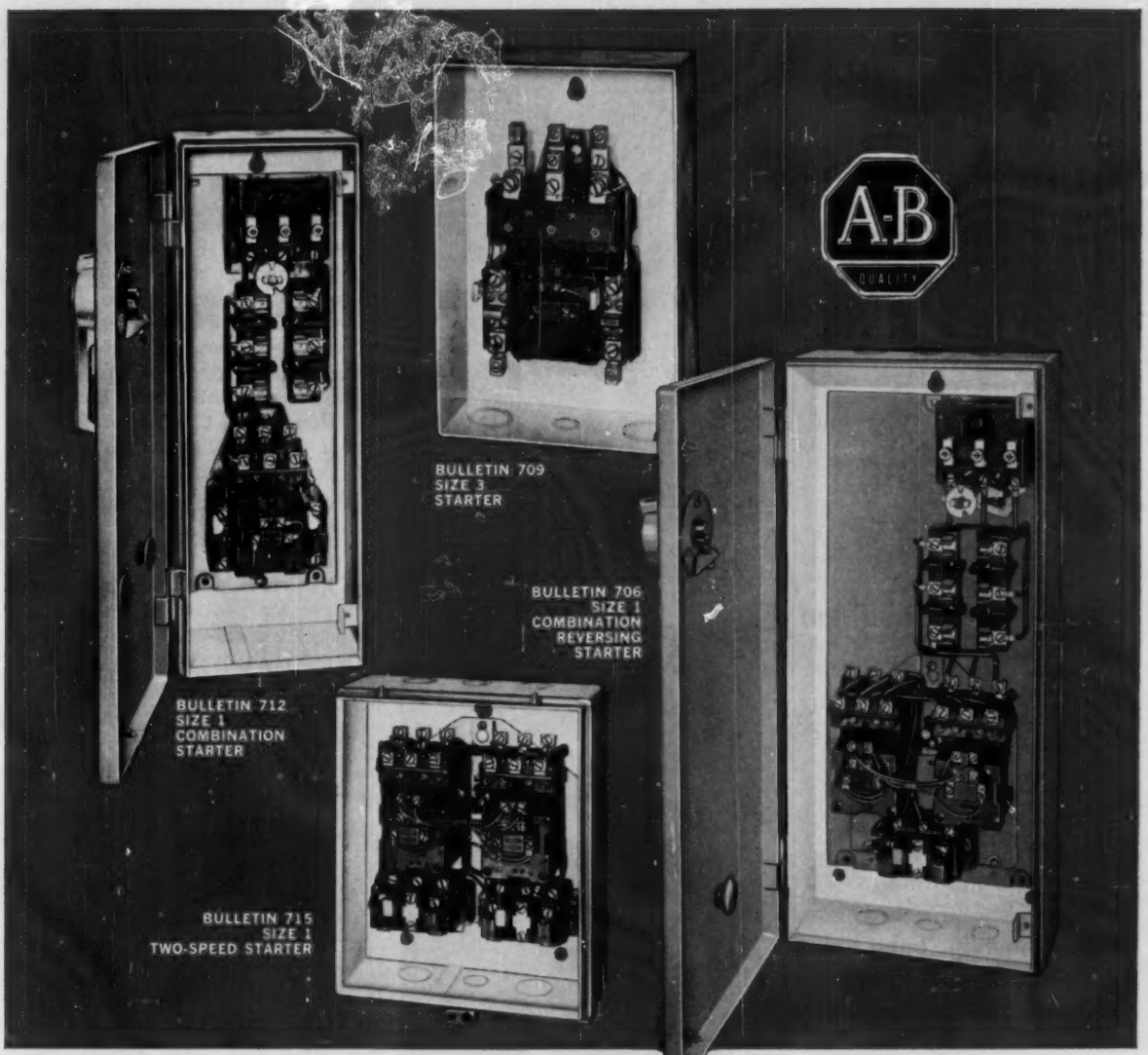
Circle 461 on Page 19

Rotary Manifold

for pressures to 250 psi is miniature unit

Model MRM-6, miniature rotary manifold is suitable for distributing air or liquid supply from a fixed center column to work stations on a revolving index table. Measuring 1 3/16 x 11/16 in., unit provides





Extra Interrupting Capacity and Extra Life

Give New Allen-Bradley Motor Controls

ALMOST UNBELIEVABLE RELIABILITY

The extra interrupting capacity that's built into these revolutionary new starters enables them to operate with ease at maximum rated capacity for prolonged periods—and still have ample reserve for emergency or unusual operating conditions. As a result, these new Allen-Bradley starters give *almost unbelievable* reliability and long life—a precious benefit for the user!

Where space is a problem, this new line warrants your interest—especially in the Size 2 and higher ratings. You'll find that small size has not been obtained at the sacrifice of "quality" or generous wiring room. In addition to the unmatched performance, you'll be pleased with the modern appearance of the enclosures. Brooks Stevens, world famous industrial designer, has given them the "eye appeal" which spells "quality" to the buyer. Please write today for the full details in Publication 6100: Allen-Bradley Co., 1333 S. First Street, Milwaukee 4, Wisconsin.

ALLEN-BRADLEY | **Quality Motor Control**

Member of NEMA

There's an R/M friction part in every make automatic transmission

... because only Raybestos-Manhattan makes all types of friction materials! For example:

- **Sintered metal plates**
- **Semi-metallic plates**
- **Cellulose plates**
- **Woven band lining**
- **Molded band lining**
- **Semi-metallic band lining**
- **Cellulose band lining**
- **Plastic friction dampeners**

What does this mean to you? It is your assurance of an unbiased recommendation of the material best for your application.

In addition, you can count on R/M for uniformly high quality; reliability of supply; prompt and extensive engineering, research and development assistance; competitive prices.

An R/M sales engineer can be at your desk within 24 hours if you will call or write. Meanwhile, why not send for our free bulletin of helpful engineering information on friction materials.

R/M

RAYBESTOS-MANHATTAN, INC.

EQUIPMENT SALES DIVISION: Bridgeport, Conn.

Chicago 31 • Cleveland 16 • Detroit 2 • Los Angeles 58

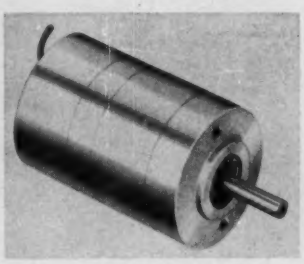
up to six supply ports from each intake connection. Intake is both threaded and tapped for use either as a ⅛-in. NPT male thread or 10-32 port. Output consists of six ports, tapped 10-32 for a variety of hose or tubing fittings. Unused ports can be plugged with screw plugs and gaskets. Unit is brass and silicon bronze with Buna-N seals. Air flow rate at 50 psi is 5.9 cfm, and recommended working range is up to 250 psi. **Clippard Instrument Laboratory Inc.**, 7390 Colerain Rd., Cincinnati 39, Ohio.

Circle 462 on Page 19

Permanent-Magnet Motor

is 1-in. diam unit

Type HYLM permanent-magnet motor is a 1-in. diam, dc unit which meets MIL-M-8609 (ASG). Features include precision ball bearings, constant-pressure springs to insure long brush life, and explosionproof housings. Typical characteristics for a 27-v unit are:



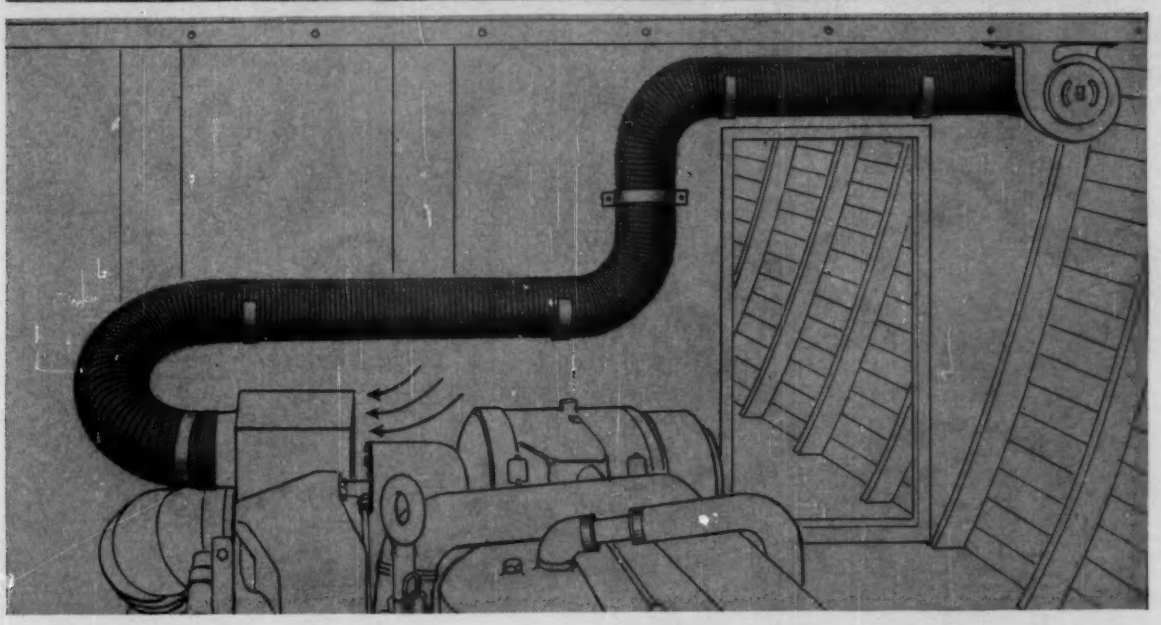
Torque, 1.0 oz-in.; rpm, 17,000; 0.85 amp; 23 w. Typical applications include program switches, tuning mechanisms, timing devices, cooling fans and blowers, and electromechanical actuators. **Dept. 2411, Motors & Components Div., Barber-Colman Co.**, Rockford, Ill.

Circle 463 on Page 19

Hitch Pin

has pointed end for proper alignment of holes

Cotterless pointed hitch pin has a main body of cadmium-plated steel; working parts of the self-locking feature are stainless steel. Pin is suitable for temporary or interchangeable hitching of parts, tools, units, or assemblies. Pointed end facilitates the proper alignment of the two holes and the large head provides



Aboard Chris-Craft's new 55-ft. "Constellation", Flexible Tubing solves the problem of how to vent engine supercharger . . .

Proof that today's designers can make Flexible Tubing do almost anything

Designing a ventilating duct for the engine supercharger on Chris-Craft's new 55-ft. "Constellation" was a problem. The duct must take tight turns . . . resist vibration, corrosion, high temperatures.

That's why the Caterpillar marine engine, which powers the Constellation, was equipped with Flexible Tubings nonmetallic "Flexflyte"!

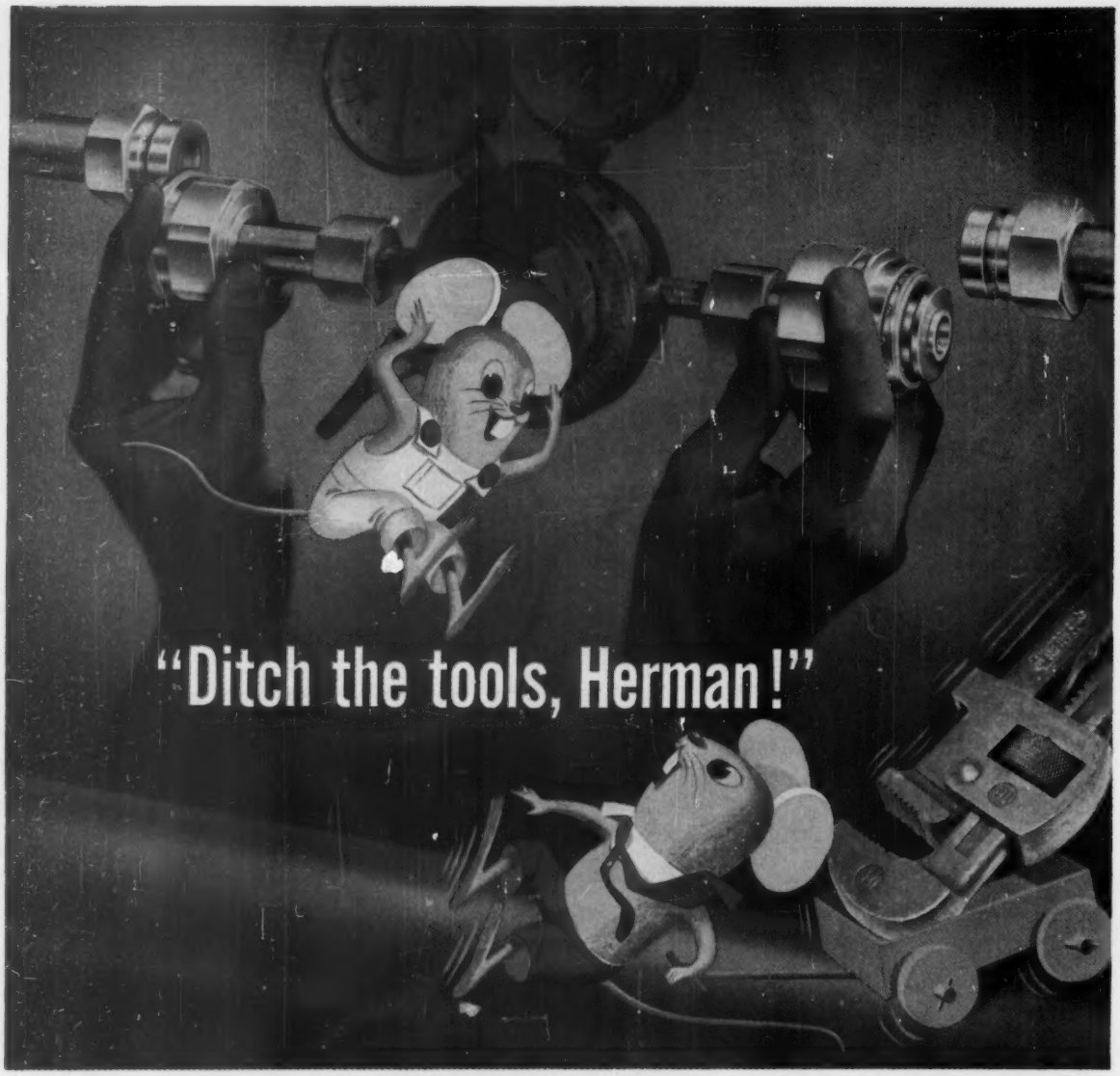
"Flexflyte" snakes through tight compartments. It absorbs engine vibration, wave shock . . . resists corrosion. Flameproof, too — so essential on boats!

If you work on any kind of original equipment where the handling of air, gases, liquids or light solids is a design problem, there's a Flexible Tubing product just right for the job. A variety of coverings, coatings and sizes is available to meet your specifications.

Flexible Tubing is at work today in farm machinery, electronic equipment, aerospace products, many other places. Learn how it can help *you*. Call your Flexible Tubing regional office today.

Flexible Tubing Corporation

69 New Whitfield St., Guilford, Conn.
Anaheim (Los Angeles) • Hillside (Chicago)
Atlanta • Cleveland • Dallas • Denver • San Francisco • St. Louis • Wichita



With new Snap-Tite RIGID-LINE Couplings, the valve snaps into place by hand!

New Snap-Tite Rigid-Line Couplings enable quick addition or removal of relief valves, flow control valves, check valves, in permanent hydraulic piping installations. To assemble or disassemble, simply pull collars back and release. No tools necessary.

Rigid-Line couplings were designed solely for permanent piping to give you all the advantages of "quick-connect, quick-disconnect" in a fixed rigid line. They do *not* require a flexible hose at either end.

Snap-Tite Rigid-Line Couplings are leakproof, seal on a sandwiched rubber gasket. No cleaning problems, either. Since the flow is through straight pipe only, you can scour them easily. Ideal for perishable fluid applications. Gasket removable for washing.

For more details write

Snap-tite

UNION CITY, PA.

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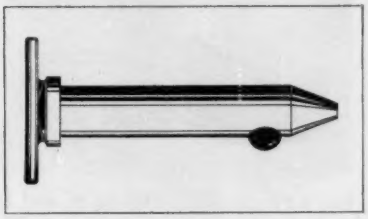
H-1679



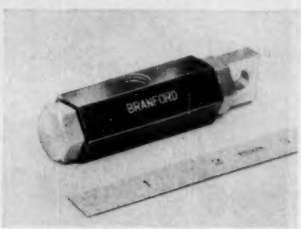
a means of quick removal. Pin can be furnished in practically all sizes, with one or several locking points positioned where desired in the body of the pin. **Rein Leitzke,** Dept. HP, Hustisford, Wis.

Circle 464 on Page 19

Pneumatic Vibrator

is 3 in. long and weighs 5 oz

Vibrajust midget vibrator with a reciprocating piston, Model 7803, has 0.358-in. piston bore, is 3 in. long, has a stroke of 0.094 in., piston mass of 12.5 grams, and weight of 5 oz. Unit operates on 10-psi line pressure to 80 psi, with a frequency range between 6000 and 18,000 vibrations per min. Recommended operating range is 10 to 20 psi for a low noise level. Vibrator has plugless air passages, and is avail-



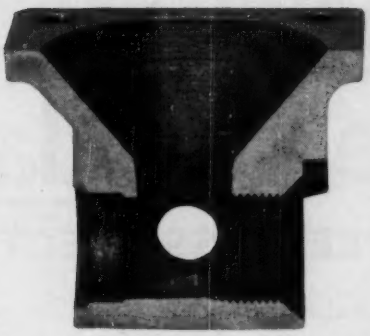
able from stock with single-attaching head (shown). **Branford Co., Div., Electro-Mechanics Inc.,** 130 Glen St., New Britain, Conn.

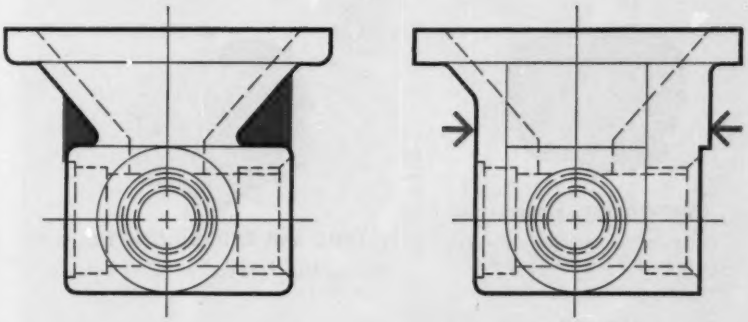
Circle 465 on Page 19

Starts Counter

tiny unit weighs 3/4 oz, is ½ in. square

Four-digit starts or events counter employs a drum counter having a range of 9999 events or starts. Unit is ½ in. square by 1-9/16 in. long, weighs ¾ oz, and operates from a 28-v dc source. Device is driven by a microminiature motor measuring ⅜ in. diam by 9/32 in. long. Motor





REDESIGN CUT COSTS

A CASE IN POINT—Hamilton Foundry engineers suggested a single design change which saved over 50% in pattern costs and cut the unit price 28% on the quantities ordered.

Curtis Automotive Devices, Inc. uses this casting on their DYNA-FOG® Insecticide Applicator. As initially designed, the part had an undercut which required cores in the mold. Hamilton Foundry's engineers suggested a simplified design which eliminated the cores and made dramatic savings possible in tooling costs and unit prices. You can expect this kind of engineering assistance from Hamilton Foundry.

When buying castings, the skill and integrity of Hamilton Foundry is your best insurance that specifications—and delivery schedules—will be met.

GRAY IRON • ALLOYED IRON • MEEHANITE® • DUCTILE (NODULAR) IRON • NI-RESIST • DUCTILE NI-RESIST • NI-HARD

HAMILTON FOUNDRY INC.

1551 LINCOLN AVENUE • HAMILTON, OHIO • TWinbrook 5-7491

Circle 316 on Page 19

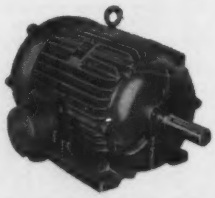
Special Motors are Standard

AT PEERLESS ELECTRIC!

Need a special motor? Our knowledge may aid in reducing the engineering time. We are the exclusive supplier to many manufacturers for motors with unusual operating conditions and duty requirements. Write us your needs!

DRIP-PROOF (open type)

Completely protected against dripping liquids and falling particles.

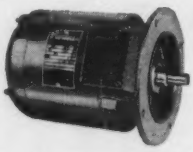


TEPC and EXPLOSION-PROOF

External fan draws cool air across motor toward driven machine.

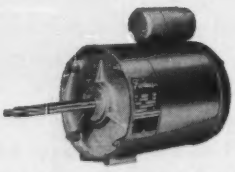
DIRECT CURRENT

High starting torque, good overload capacity and high electrical efficiency. For rough usage.



WEATHER-TIGHT SPECIAL FLANGE

EXPLOSION-PROOF TORQUE MOTOR WITH BRAKE



SPECIAL FLANGE REVERSING HOIST MOTOR, SINGLE PHASE

ENGINEERING DATA: Special mountings. Various modifications—special shaft features; paint and varnish treatments, Class A, B, F, H insulation. Peerless builds to standards and specifications of JIC, AIEE (including AIEE No. 45 Marine Duty), ABS, Federal and Military.

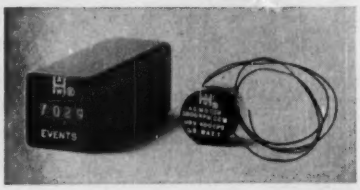
WRITE FOR BULLETINS: Space-Saver, SP-1; Torque, T-1; Complete Line, SDA-155. *Peerless Electric Division, H. K. Porter Company, Inc., W. Market Street, Warren, Ohio.*

PEERLESS ELECTRIC DIVISION

PORTER

H. K. PORTER COMPANY, INC.

PORTER SERVES INDUSTRY with steel, rubber and friction products, asbestos textiles, high voltage electrical equipment, electrical wire and cable, wiring systems, motors, fans, blowers, specialty alloys, paints, refractories, tools, forgings and pipe fittings, roll formings and stampings, wire rope and strand.



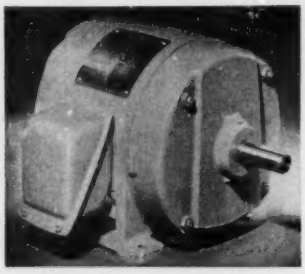
has a torque of 0.00005 oz-in. and is a single-phase hysteresis type. A. W. Haydon Co., Waterbury, Conn.

Circle 466 on Page 19

Synchronous Reluctance Motors

in 1 to 5-hp units

Tri/Clad 55 synchronous reluctance motors offer the same horsepower-per-frame as induction-motor counterparts. They are designed for applications where the load is not constant, but where zero-slip, constant-speed operation is required. Motors operate at efficiencies as high as 80 per cent. With external inertia equal to twice rotor inertia, they offer approximately 150 per cent pull-out torque, 100 per cent pull-in torque, and lock-rotor torque of more than 250 per cent of full-load value. Available in both dripproof and enclosed models, motors are



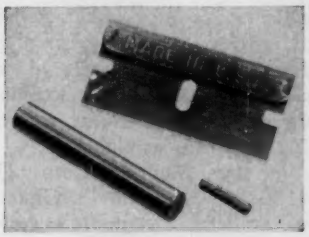
rated 220/440-v, three-phase, 60-cycles, 1 to 5 hp. **General Electric Co.**, Schenectady 5, N. Y.

Circle 467 on Page 19

Dowel Pins

of stainless steel

Stainless-steel dowel pins used in the instrument, radar, computer, meter, and missile industries range in size from 1/32 to ½ in. diam in increments of 1/32 and 1/64-in., with a tolerance of ±0.002 in. Type 416, 420, 440, and drill-rods pins, hardened and ground to specifications, are manufactured to MS print. Special diameters, lengths,



chamfers, bevels, materials, heat treatments, and finishes can be ordered to meet requirements. **Star Stainless Screw Co.**, 699 Union Blvd., Paterson 2, N. J.

Circle 468 on Page 19

Corrosion-Resistant Alloys

have good fabricating and finishing qualities

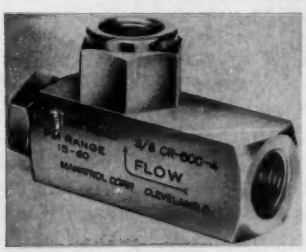
Uniloy 430 Mo and 435 Mo straight chromium, stainless-steel alloys combine high corrosion resistance with excellent fabricating and finishing qualities. Corrosion resistance is provided by the addition of molybdenum to the stainless steel. In addition to the molybdenum, Uniloy 435 Mo contains an element to control roping encountered in severe stretch-bending and deep-drawing operations. Materials are available in a full range of strip and wire sizes. **Universal-Cyclops Steel Corp.**, Bridgeville, Pa.

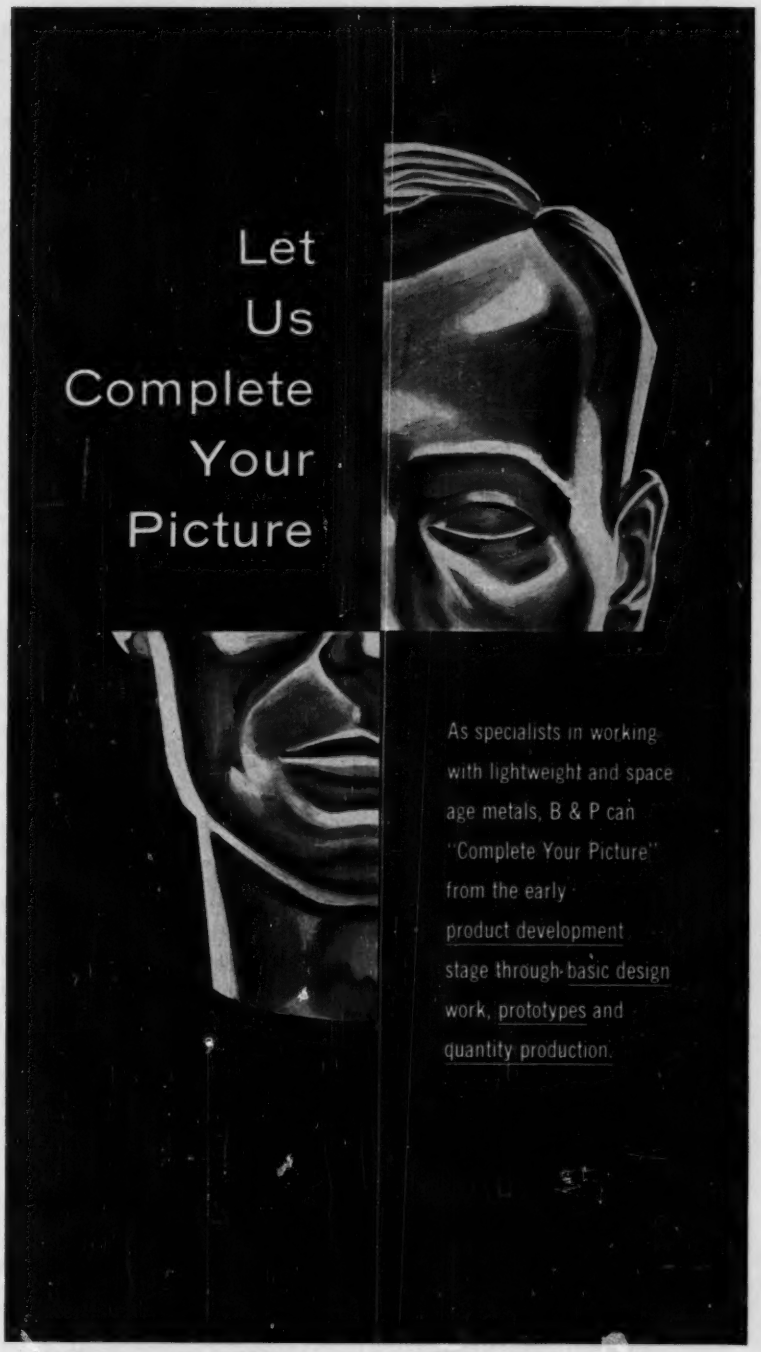
Circle 469 on Page 19

Check, Relief Valves

have cracking pressures from 5 to 150 psi

CR right-angle check (shown) or relief valves allow flow in one direction and provide positive stoppage in the other. Internal tamperproof cracking-pressure adjustments provides cracking pressures from 5 to 150 psi. Guided poppet incorporates a nonextrudable soft seal which cannot be washed out by the fluid stream. Poppet design gives

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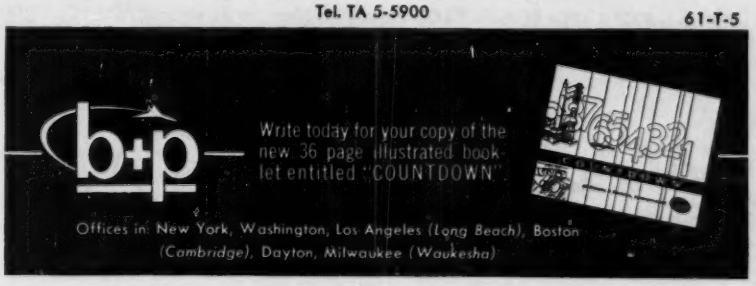
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Circle 318 on Page 19

Standard
high speed coupling.

standard: 20,000 rpm special: 70,000 rpm

Waldron high speed gear couplings are made with special care to prevent vibration—the usual troublemaker at high speeds. All parts are machined and inspected to close tolerances. Every assembled coupling is dynamically balanced on an arbor. Forged alloy steel gives them reliable strength, and they can be furnished grease-packed or continuously lubricated. Write for bulletin S-1500.

Standard size	HP/100 rpm	Max. rpm	Max. bore
1½ HS	19	20,000	1½
2 HS	24	18,000	2
2½ HS	50	15,000	2½
3 HS	87	12,500	3
3½ HS	125	11,000	3½
4 HS	210	9,500	4
4½ HS	305	8,500	4½
5 HS	410	7,500	5
5½ HS	550	6,500	5½
6 HS	675	6,000	6

WALDRON-HARTIG, Box 791, New Brunswick, N. J.
a division of Midland-Ross Corporation MR

WALDRON
Makes it easy to pick the right Couplings

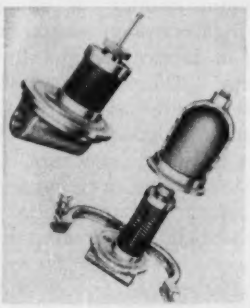
excellent reseating characteristics and insures quiet, chatterproof operation. Having one-piece, all-steel, leakproof bodies, valves accommodate operating pressures to 5000 psi. They are available in ¼ to 1¼-in. sizes. **Manatrol Corp.**, 2372 W. 7th St., Cleveland 13, Ohio.

Circle 470 on Page 19

Compression Spring Filter

filters high volumes of any fluid

Permanent, easy-to-clean filter, designated Compression Spring Filter, permits filtering high volumes of any fluid that can be pumped. Construction of the element is based on two interwound springs, one wire coiled around the other. Medium-



pressure model (shown) handles line pressures of 1000 lb. Noncollapsible element of the filter performs satisfactorily at differential pressures exceeding 100 psi. Filter is offered in three models for pressurized pipelines, suction tubes, and immersion pumps. Four elements are available with filter action comparable to 20, 40, 60, and 100-mesh screens. Filter is snapped apart for cleaning. **Chrom-O-Lite Co.**, 2701 East 78th St., Minneapolis, Minn.

Circle 471 on Page 19

Insulated Rivets

have large-diameter oval heads

Insulet rivets consist of semitubular metal rivets with shanks and under-the-head surfaces covered with plastic insulation. They now have large-diameter oval heads, providing greater head bearing area and lower design profile than former flat heads. Rivets are available in aluminum,

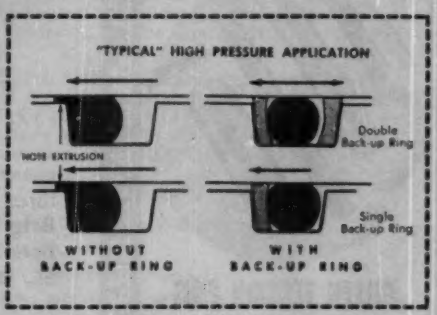
Circle 319 on Page 19

NOW—Increase O-Ring Life and Reduce Costs with...

Parbak*

The only contoured and continuous back-up ring... simplified, easy-to-assemble, resists higher pressures!

Here's the first really new back-up ring in years . . . Test after test, both in the field and laboratory, has proved that Parbaks* greatly increase O-ring life. In addition Parbaks* improve lubrication, are easy to assemble, and resist higher pressures — *yet they actually cost less* than back-up rings for similar useage!



Why not get the facts about these unique rings, now. Send for catalog 5482—8 pages of design data and other material about Parbaks.* It's free, of course.

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Culver City, California and Cleveland, Ohio

A DIVISION OF PARKER-HANNIFIN CORPORATION

Circle 320 on Page 19

* Trade Mark

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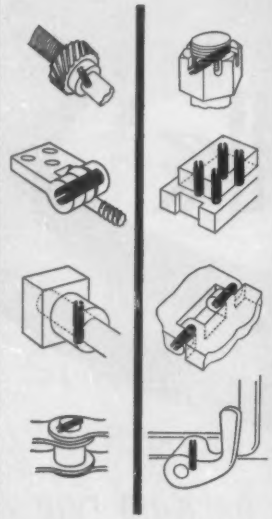
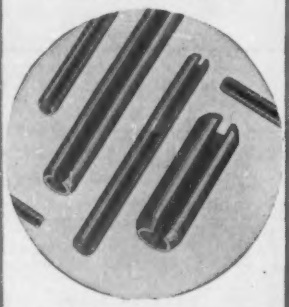
Self-Fitting
TENSION PINS
Speed
Many Assemblies
and Stay Put!



Tension holds them Tight!
in Metal/Plastics/Ceramics



GILLEN TENSION PINS
are hollow, hardened, chamfered-end spring steel fasteners designed to hold many materials efficiently and reduce production-assembly costs.
Diameters: 3/64ths to 1 inch.
Lengths: from 3/16ths inch.
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Circle 321 on Page 19

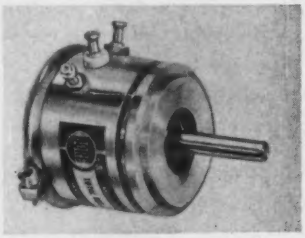
brass, steel, and other metals, in shank diameters of 1/16, 3/32, 1/8, and 3/16 in. Pylon Co. Inc., Attleboro, Mass.

Circle 472 on Page 19

Miniature Potentiometer

has resolution from 229 to 900 turns

Series 2440 precision potentiometer is a 7/8-in. diam, single-turn unit. It is linear over specified resistance ranges of 10 to 50,000 ohms, and resolution ranges from 229 to 900 turns. Housings and front-bearing mounts are one-piece machined aluminum for maximum heat dissipation and permanent concentricity. Micropot unit meets a full range of military specifications. Maximum



power rating is 3 w and temperatures range from −55 to +125 C. Borg Equipment Div., Amphenol-Borg Electronics Corp., 120 S. Main St., Janesville, Wis.

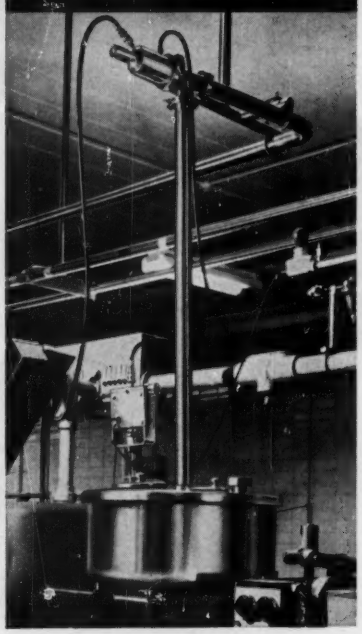
Circle 473 on Page 19

Hydraulic Cylinders

for operation to 3500 psi

Series HH interchangeable hydraulic cylinders have 1 1/8 through 14-in. bores with 18 mountings, for operation to 3500 psi. Cylinders meet or exceed JIC standards, and have tie-rod construction for high strength and shock loading. Long-wearing, easily maintained rod cartridges are removable with a wrench. Four different types of

A-P-C
automatic
FLOW CONTROL



POSITIVELY... SHUTS OFF
POSITIVELY... THROTTLES
POSITIVELY... OPENS

Maintains constant liquid level in balance tank, filler bowl or wherever a uniform level is required.

Only with a combination like A-P-C's new Wizard level control and air operated automatic throttling valves can you be guaranteed of safe positive flow control. Protects against container over and under fills; avoids spillage and operates even under severe turbulence.

Look to Alloy Products Corp. for flow control components and systems.

Sold exclusively by the
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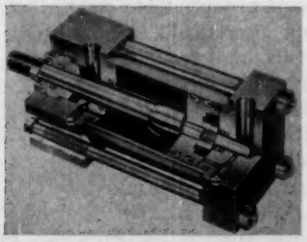
Circle 322 on Page 19



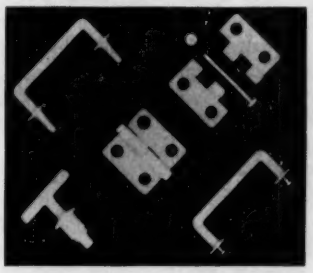
piston packing are available for various applications. Tapered cushions eliminate cushion-adjusting screws, provide positive, gradual deceleration, and eliminate shock upon entrance of cushion piston. Sheffer Corp., 326 W. Wyoming Ave., Cincinnati 15, Ohio.

Circle 474 on Page 19

Drawer Handles, Hinges

are fabricated of nylon

Drawer handles and cabinet hinges available for use in electronic installations are made of nylon to withstand high temperatures and provide good chemical resistance. Line will not conduct electricity,



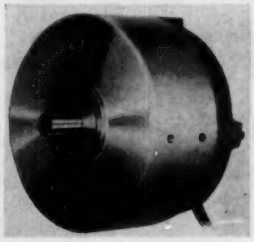
and resists rust and corrosion. Hardware Designers Inc., P. O. Box 4, South Hackensack, N. J.

Circle 475 on Page 19

Induction Motor

is 1/7-hp unit for continuous duty

E-10-1A thermally protected induction motor for continuous duty



KLIXON MOTOR CONTROLS COVER

ENTIRE SPECTRUM OF PROTECTION

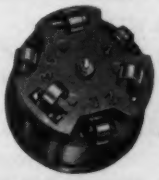
This snap-acting on-winding protector (9850 type) is typical of the built-in protection KLIXON motor controls offer to prevent overheating and burnout for all types of AC motors. This precision-calibrated, miniature protector is attached directly to motor winding, and can be dipped and baked as part of it. Responsive to both current and temperature, it provides positive make and break action, vibration resistance, and the dependability of all KLIXON protectors.

Ranging from the simplest circuit breaker to complete motor protection . . . from the end-bell mounted, 3-phase protector (see photo below) to the on-winding 9850 type protector above, the KLIXON motor protector spectrum is the most comprehensive available to electric motor manufacturers and their customers. The spectrum brings KLIXON's wealth of application knowledge and manufacturing experience to the manufacturer . . . lets specific service conditions determine protection needs.

How KLIXON Motor Protector Spectrum Works:

As level of protection increases . . .

- Motor adaptability to a variety of applications increases.
- The protected motor is affected less by high or low ambient, or other external conditions.
- Reliability and accuracy increase.
- Overall application testing costs decrease.
- You get greater protection against motor failures due to failure of allied components.



Find out how the KLIXON SPECTRUM OF MOTOR PROTECTION can save you money. Request complete Motor Controls catalog and location of nearest KLIXON field engineer by writing:

METALS & CONTROLS INC.
3209 FOREST STREET • ATTLEBORO, MASS.
A CORPORATE DIVISION OF
TEXAS INSTRUMENTS
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Denison LOXSWITCH Limit Switches operate with the dependability of Old Faithful. Oil- and dust-tight features, superior electrical characteristics and mechanical design result in three to five times longer life than comparable switches.

L100W HEAVY DUTY LIMIT SWITCH

- 45 CIRCUIT ARRANGEMENTS.
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MODEL M PRECISION LIMIT SWITCH

- LONG MECHANICAL LIFE nylon latch mechanism.
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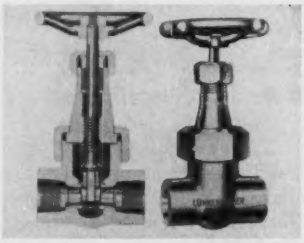
*Wire with **LOXSWITCH** and you wire for good!*

provides dependable service over a long operational span. Motor is totally enclosed and conforms to the applicable portions of MIL-M-7969 and MIL-E-5272. Typical data include: Horsepower, 1/7 hp; power, 208 v, 400 cps, 3 phase; speed, 5500 rpm; and weight, 6 lb 10 oz. **Kearfott Div., General Precision Inc.**, 1150 McBride Ave., Little Falls, N. J.

Circle 476 on Page 19

Small Gate Valve

in union or bolted-bonnet design



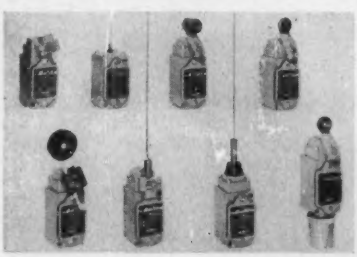
Inside-screw small steel gate valve is designed for fast installation in a limited space. Valve has screwed or socket ends, available in a bolted-bonnet design in 1½ and 2-in. sizes, and in a union bonnet (shown) in sizes ¼ through 1 in. Inside-screw rising stem, solid-wedge disc, and rolled-in seat rings are features of the valve. Valve is rated 800 lb at 850 F and 2000 lb at 100 F. Types are designated Figures 8004, 8005, 8007, 8008. **Lunkenheimer Co.**, Cincinnati 14, Ohio.

Circle 477 on Page 19

Limit Switches

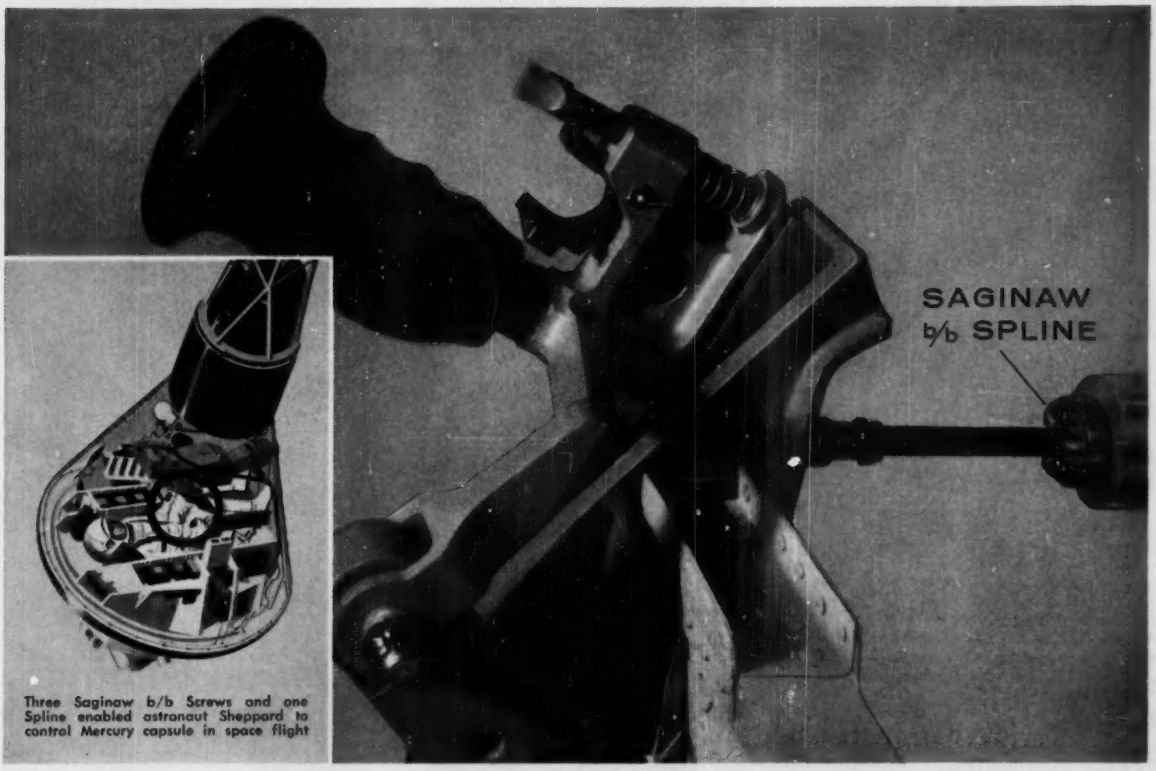
oiltight units have flexibility of operation

New operators and optional features have been added to Type L precision oil-tight limit switches which provide depth and flexibility



Circle 324 on Page 19

EFFICIENCY in a world of motion



Three Saginaw b/b Screws and one Spline enabled astronaut Sheppard to control Mercury capsule in space flight

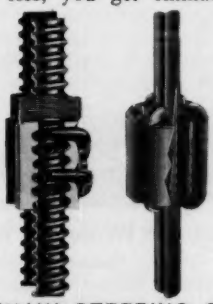
No margin for malfunction

ABSOLUTE RELIABILITY was vital in the functioning of the Saginaw Ball Bearing Screws and Splines incorporated into the control system of space capsule Mercury. Three b/b screws extended a periscope out of the capsule and retracted it, opened and closed the door covering the periscope's eye. One b/b spline controlled the capsule's pitch, yaw and roll permitting the astronaut manual control of the space vehicle in flight.

Perhaps few, if any, of your designs will ever have to meet comparable crushing G forces. Nevertheless, you get similar reliability with every b/b screw or spline that bears the Saginaw trademark. Over 58,000,000 have been produced and successfully used in a wide variety of applications.

Other actuation advantages of Saginaw b/b Screws:

HIGH EFFICIENCY exceeding 90% of input;
LIFE predictable within 10%;
STEPLESS CONTROL over the entire length of the stroke;
HIGH REPEATABILITY of any position;
PRECISE POSITIONING — no stick-slip nor expansion due to friction induced heat;
EASE OF SYNCHRONIZING multiple units;
SMALLER COMPONENTS in the power source and drive transmission, and
UNIFORM FEED RATE under varying load conditions.



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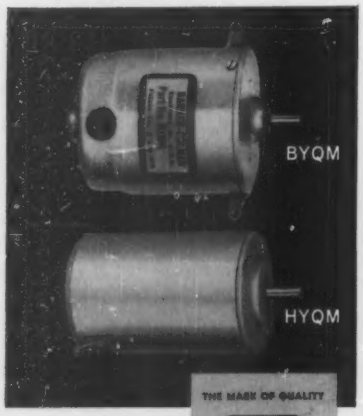
SAGINAW STEERING GEAR DIVISION • GENERAL MOTORS CORPORATION • SAGINAW, MICHIGAN

Barber-Colman battery-operated d-c motors with integral governors



ideal for many of today's portable applications

THE MARK OF QUALITY
BARBER COLMAN

Type BYQM, top, is inexpensive, yet of excellent quality to meet consumer demand for dependability in mass-produced goods. Type HYQM is an exceptionally fine-quality battery-operated motor for the more demanding applications such as portable dictating equipment.

BYQM-Typical Specifications

Voltage range.....approx. 3 to 30
Governed speed.....1200 to 6000 rpm
Torque.....0 to .20 oz-in.
Diameter.....1.29"

HYQM-Typical Specifications

Voltage range.....4.5 to 30 volts
Governed speed.....1500 to 5000 rpm
Torque.....0 to .20 oz-in.
Diameter.....1"

TYPICAL APPLICATIONS

PORTABLE DICTATING MACHINES
PHOTOGRAPHIC EQUIPMENT
DRIVE MECHANISMS
TAPE PLAYERS
ROTATING BEACONS
DEPTH FINDERS
BLOWERS
PORTABLE INSTRUMENTS
ROTISSERIES

WRITE FOR HELPFUL DATA SHEETS on BYQM and HYQM battery-operated motors specifically designed to fit individual customer applications.

BARBER-COLMAN COMPANY
DEPT. U, 1873 ROCK STREET, ROCKFORD, ILLINOIS

Circle 326 on Page 19

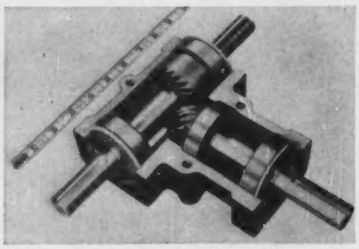
of application. Nine new limit switch operators and switches are available, as well as five new features furnished as selected options. **Cutler-Hammer Inc.**, 315 N. 12th St., Milwaukee 1, Wis.

Circle 478 on Page 19

Gear Unit

is packaged, right-angle type

Model 805 gear unit is available for applications requiring 2:1 speed reduction. Spiral bevel gears and double-shielded ball bearings are



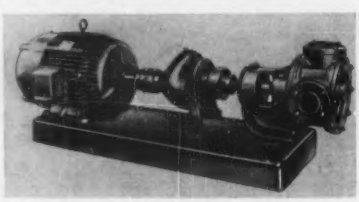
enclosed in Type 356 aluminum-alloy housing for strength and minimum weight; shaft extensions are Type 316 stainless steel. Over 18 models of packaged right-angle gear units range from ¼ to 8 hp, with 1:1 or 2:1 ratios. **Crown Gear Co.**, 320 Park Ave., Worcester, Mass.

Circle 479 on Page 19

Large-Capacity Pumps

for pressures to 200 psi

Three large capacity pumps have been added to a line of helical gear-driven units. These include 200, 300, and 450 gpm, heavy-duty, positive-displacement, rotary pumps suitable for pressures to 200 psi. Compact, independently mounted, size-C helical gear reducer accepts any one of five gear ratios capable of transmitting a maximum of 25 hp at 350 pump rpm and 40 hp at 520 pump rpm. The three sizes of pumps, with five gear ratios, and



SEAL WITH A THOUSAND LIVES

NEW

SEALOL "605" Rotating Metal Bellows SEAL

- **Only one moving part**
- **Unlimited shelf life**
- **−350° to +800°F**

Because every "605" is suitable for a thousand and one different applications, you can reduce seal inventories and spares up to 40%. The secret is in the fact that every "605" is fully pressure balanced and uses no dynamic elastomers. Result? Unlimited shelf life and, if certain basic requirements are met, any place a compact "605" will fit, it will work.

Try one and see for yourself. Sizes from .875" to 2.500" shaft diameter are available for immediate delivery. Send today for catalog and price information. No obligation, of course.

SEALOL INC.

349 Post Road, Providence 5, R. I.

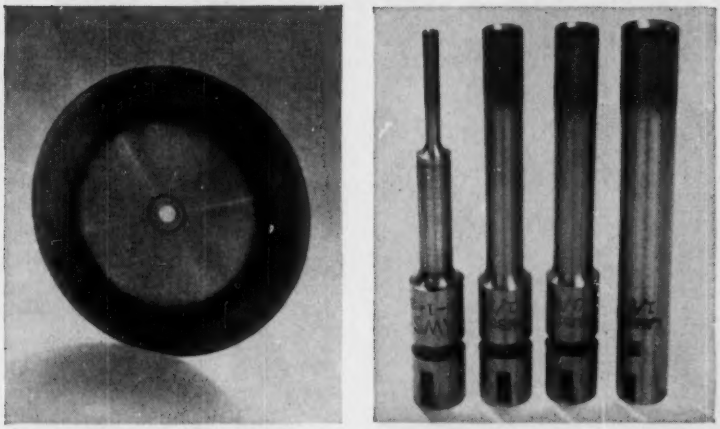
New York • Chicago • Cleveland • Los Angeles
San Francisco • Houston • Philadelphia
Paris, France • Uxbridge, England

Circle 327 on Page 19

Linde Coatings & materials News

LINDE COMPANY, DIVISION OF UNION CARBIDE CORPORATION

Long wear for precision cutting parts now comes in thin coatings—.001" thick



Two important industrial cutting tools whose working lives have been multiplied by LINDE Flame-Plating tungsten carbide coatings: Rubber skiving knives (l.) and paper drills.

SUPER-THIN coatings of tungsten carbide and aluminum oxide—in the .00075" to .002" range of thickness—now keep many industrial cutting surfaces on the job many times longer than previously, yet preserve the precision fit needed for optimum cutting. The result: important savings in downtime and operating costs.

These tough, long-life precision coatings are applied by LINDE's Flame-Plating process, which "blasts" molten particles of tungsten carbide onto specified areas of wearing surfaces until the particles are built up to the desired degree of thickness.

Typical examples of longer wear

Because their cutting surfaces are Flame-Plated with tungsten carbide coating, rubber skiving knives that formerly required resharpening after every shift now stay in use 15 times longer. The knives also have the advantage of a self-sharpening effect. As the softer steel base wears more rapidly than the hard, tungsten carbide coating, a sharp edge is always presented to the material being cut.

Tungsten carbide coating enables serrated knives used in cutting plastic sheeting to process three times as much material before the first re-sharpening is necessary.

A coating of .001" thickness on the inside cutting surface of surgical shears has reduced their rate of wear by as much as 33 percent.

Flame-Plating proved so revolutionary for household cutlery that the manufacturer built his merchandising theme around *"The Greatest Development in 2000 Years of Cutlery Making—a Cutting Edge of Tungsten Carbide."*

Solves many wear problems

Tungsten carbide coatings of microinches thickness are equally effective wherever metal parts or working surfaces are exposed to abrasion, galling, erosion, fretting, corrosion, or high-temperature wear. Coatings are applied by the LINDE's 6,000-degree Flame-Plating process without distortion of the work piece or changes in properties of base metals.

For full information on Flame-Plating for your particular application, check and mail the coupon below.

Need to production-polish tungsten carbide surfaces?

It's easy with LINDE metallographic production-polishing aluminas—available in grades for three types of finishing: For high stock removal, 1 micron C; for moderate stock removal and ¼ rms finish, 0.3 micron A; for super polish, 0.05 micron B.

LINDE has developed special techniques for production-polishing of semiconductors and soft metals (such as brass), also new ideas for production-polishing hard metals, including micrometer anvils, hardened bearing races, routine metallographic samples. Get help with polishing techniques to meet your requirements. Send coupon below.

Jet planes landed by ruby-against-sapphire wear pads

In the automatic landing computer of a modern jet interceptor, a tiny ruby ball held to tolerances of 30 millionths oscillates against a synthetic sapphire plate flat to 1/10 light band, as a reference plate for a computer to translate radar approach signals into hydraulic actions.

Approximate size: Ruby ball, sapphire plates.

A similar wear surface bears on the cam head. Certain fly wheel governors also have sapphire wear surfaces.

This 70,000 to 300,000 psi LINDE material has a hardness second only to diamond, unlubricated static friction coefficient of .18, and dynamic of .08 against itself in moderate loads. It is economically suited for wear applications such as gage points, textile guides, optical inspection flats, and flow valves. Send coupon for information.

CHECK—CLIP COUPON—ATTACH TO BUSINESS LETTERHEAD

Linde Company
270 Park Avenue
New York 17, N. Y.

Please send data on the items checked:

- ☐ LINDE Flame-Plating Process
- ☐ LINDE Alumina Abrasive Powders
- ☐ LINDE Synthetic Sapphire & Ruby

UNION CARBIDE

LINDE COMPANY

"Linde" and "Union Carbide" are registered trademarks of Union Carbide Corporation

To help you in designing machinery—

68 PAGES
of engineering data

Here's a technical manual that will help you in selecting herringbone, helical and spur gears for industrial applications. Data compiled by Farrel engineers are based on forty years of experience in designing and manufacturing gears and gear units.

Nomenclature, formulas for determining dimensions, procedure for calculating horsepower ratings and example calculations are clearly outlined. Gears for special use such as in rolling mills and kilns, and for pump rotors are discussed in detail.

The most comprehensive book of its type ever published, it is concise and easy to use. Where possible, formulas have been simplified to reduce the calculations required.

Your copy will be sent *without charge.* Write today on your company letterhead.

FARREL-BIRMINGHAM COMPANY, INC.
344 Vulcan Street, Buffalo 7, N. Y.
Plants: Ansonia and Derby, Conn., Buffalo and Rochester, N. Y.
Sales Offices: Ansonia, Buffalo, Akron, Chicago, Minneapolis, Los Angeles, Salt Lake City, Tulsa, Houston, Atlanta
European Office: Piazza della Republica 32, Milano, Italy

FARREL ®

FB-1225

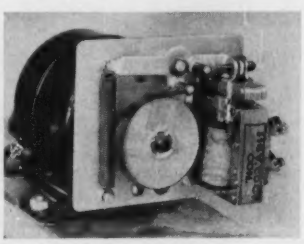
either a 1750 or 1150 rpm motor, permit a capacity range from 65 to 450 gpm. **Viking Pump Co.,** Cedar Falls, Iowa.

Circle 480 on Page 19

Solenoid-Operated Brake

for shafts to ⅜ in. has braking torque of 2 to 4 lb-in.

Solenoid-operated, precision brake for subfractional-horsepower electric motors is designated Instop. It is suitable for use in stopping overtravel of motors used in computer mechanisms, tape transports, turntables, and vending machines, where instant stop is necessary. Unit has a braking torque of 2 to 4 lb-in. for shafts to ⅜ in. All parts are cadmium-plated stainless



or bronze. Brake uses a band that almost completely encompasses the brake drum. Constant-duty solenoid, furnished in ac to 230 v or dc as low as 12 v, is connected parallel with the motor. Without load, motor is stopped in less than 20 deg. **Midwest Automatic Inc.,** 510 Third St., Des Moines, Iowa.

Circle 481 on Page 19

One-Part Adhesive

requires no mixing prior to use

Rubbapox has the rubbery qualities and ease of application of rubber-based adhesives plus good qualities of epoxy adhesives. It contains neither water nor solvents, and is 100 per cent solids. The one-part adhesive requires no mixing prior to use, is applied to one surface and placed in contact with the other surface, curing over night. Bond grows stronger several days after application. Adhesive is waterproof and resistant to acids and alkalies. It adheres to almost any surface, and shows excellent adhesion to

Circle 329 on Page 19

some grades of polyethylene. Material can also be used as a caulking compound or waterproof sealer. It remains permanently flexible and performs well at temperatures from −80 to +250 F. It laminates polystyrene, polyurethane, polyethylene foams to steel, aluminum, Cycolac. Available in 1 and 5-gal containers, 55-gal drums. **Rubba Inc.**, 1015 E. 173rd St., New York, N. Y.

Circle 482 on Page 19

Shock Absorbers

in 2 and 4-in. bore diameters

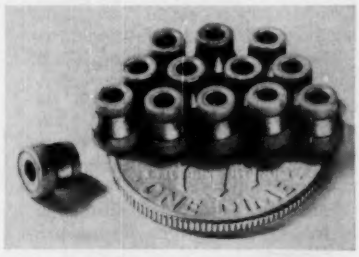
Standardized shock absorbers are available in a wide range of size and load capacities; over 60 models are presently furnished. Basic specifications are: Bore diameters, 2 and 4 in.; strokes to 8 in. in 1-in. increments; loads, 10 to 100,000 ft-lb; velocities, ½ to 100 fps; mountings, front and rear flange and front and rear foot, special mountings to order. All units are offered with either integral or external accumulators. **Ellis Fluid Dynamics Corp.**, 7344 Monticello Ave., Skokie, Ill.

Circle 483 on Page 19

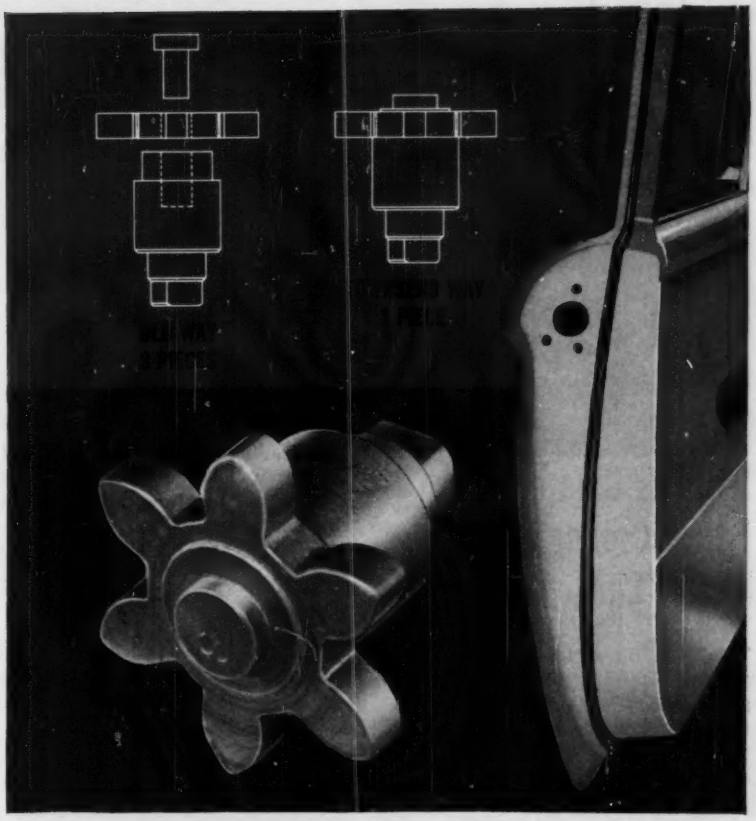
Feed-Through Capacitor

for miniature-circuit use

Microminiature feed-through capacitor, Type DA-718, has 0.16-in.. diam and is 0.165 in. high. It is rated at 100 v dcw and 250 v dct, and is available in capacities of 500



and 800 mmf. Primarily designed for miniature-circuit use, unit is inserted in a ⅛-in. diam hole and is soldered in position by means of a metalized shoulder. Write on company letterhead to **Centralab Div., Globe-Union Inc.**, 900 E. Keefe Ave., Milwaukee 1, Wis.



Auto maker saved $22 per thousand with Townsend Ultra-Special part

This Ultra-Special part is made by the Townsend Ultra-Special cold-forming process for $22 less per thousand pieces than the former three-piece assembly made by another method.

One of these automobile door latch rotors is used in each car door by a major manufacturer. Their annual savings—by using this part—is quite substantial.

Cold forming adds strength to make a tougher part while holding dimensional tolerances. In developing these Ultra-Special parts, Townsend's engineers combine such processes as cold-heading and impact extrusion—or, interim heat treatments and coatings. The result is an extended range of standard production equipment far beyond ordinary limitations.

You benefit directly by using Townsend Ultra-Special parts in the assembly of your products. Your increase in profit potential is a direct combat to competition. A Townsend engineer will be happy to discuss your production assembly. Write Townsend Company, P. O. Box 71-E, Ellwood City, Pa.

Townsend Company

ESTABLISHED 1916

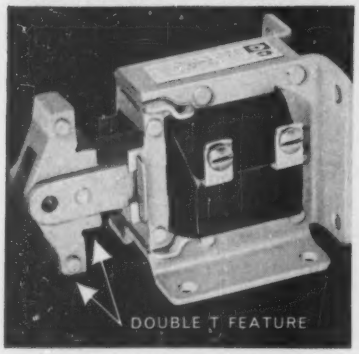
Engineered Fasteners Division

ELLWOOD CITY - PENNSYLVANIA

In Canada: Parmenter-Bulloch Manufacturing Co., Limited, Gananoque, Ontario

Circle 330 on Page 19

NEW DOUBLE T INDUSTRIAL SOLENOID



Delivers Greater Pull, Faster Cycling, Longer Life

The new 831 series of industrial solenoids designed by Controls Company, the world's largest manufacturer of laminated solenoids, will even out-perform many solenoids of larger size. Check these features:

- Double T plunger provides level pull characteristics with no power drop-off at 2/3 stroke.
- Epoxy encapsulated coil is impervious to water, oil, acid or alkalies.
- Hard chrome plated, beryllium copper core guides assure increased life.
- Heavy coat of epoxy paint on frame and core provides added protection against environmental conditions.
- Universal mounting bracket permits mounting in any position.
- Plunger has reinforced linkage design providing maximum bearing surface.

To learn how you can have improved solenoid performance at lower cost, write for Industrial Solenoid Bulletin SL-33 containing pull curves, specifications and performance facts. A complete line of commercial grade solenoids is also available. For information, ask for *Commercial Solenoid* Bulletin SL-23.

CONTROLS COMPANY OF AMERICA

APPLIANCE AND AUTOMOTIVE DIVISION
9555 SORENG AVENUE
SCHILLER PARK, ILLINOIS

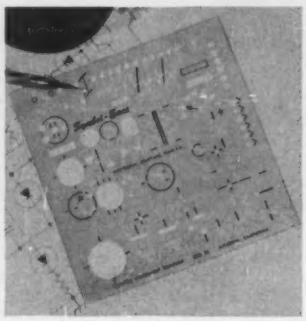
Circle 331 on Page 19

ENGINEERING DEPARTMENT
EQUIPMENT

Electronic Circuit Template

has symbols sized for 0.2-in. grid

Symbol-Ease template provides latest transistor and diode symbols in addition to those for electron tubes and electronic components. Symbols are in accordance with MIL-STD-15A, ASA, and IRE standards for electronic and semiconductor graphic symbols, and are sized for 0.2-in. grid. Cutouts are grouped for maximum convenience. All common symbols are made with horizontal motions of the template. Template is Butyrate plastic and is supplied with instructions and examples of the symbols. **Quintec Instrument Co.**, Box 85, Altadena, Calif.



Circle 484 on Page 19

Portable Strain Indicator

gives fast operation with strain gages and transducers

Type 20 portable strain indicator provides digital readout and twice the gage-factor range of previous Type N unit. Gage-Factor range in new unit is 1.50 to 4.50, compared with 1.77 to 2.22 in the previous indicator. Indicator provides operation with most strain gages in one, two, or four-arm networks, and with bonded or unbonded strain-gage transducers to provide direct indication of the measured variable. Strains are read directly as the sum of the digital counter indication and

Straits Tin Report

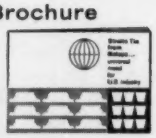
Tin-lined copper tube recently developed combines tin's corrosion resistance and malleability with the strength and ductility of copper. Pure molten tin is gas-propelled through the tubing to form a continuous, fusion-bonded tin lining that will not chip, crack or peel, and can be bent, flared, flattened or soldered. Tin provides immunity to corrosive sulfur conditions found in some natural gas and petroleum products; affords excellent resistance to flaking action that can plug lines and orifices and create hazards with gas appliances. The tin lining also prevents contamination of fluids in process lines of food, beverages, pharmaceutical and water distilling equipment and for sampling lines to laboratory or control instruments, according to its producers, Phelps Dodge Copper Products Corp.

Photo courtesy Phelps Dodge

Acid pickling of steel before hot tinning produces maximum bond strength of bearing metal to steel. Shot blasting preparation lowers bond strength, possibly because of distortion, folding and flowing during precleaning.

FREE Brochure

16 interesting pages of information about the latest uses of tin in U.S. industry. Write today for your copy.



The Malayan Tin Bureau
Dept. S-29J, 2000 K St., N.W., Washington 6, D.C.

Circle 332 on Page 19

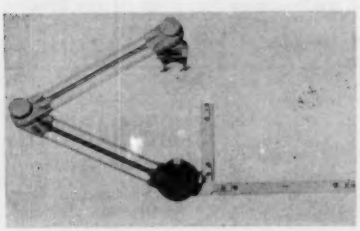
the "add-to-reading" setting. Counter gives readings from 0-5000 mu in. per in. in ¼-in. white numerals on a black background. There are 12 intervals in the range from 0-60,000 mu in. per in. Accuracy is 0.1 per cent of reading, or 5.0 mu in. per in., whichever is greater, and readability is 1 mu in. per in. **Electronics & Instrumentation Div., Baldwin-Lima-Hamilton Corp.**, 42 Fourth Ave., Waltham 54, Mass.

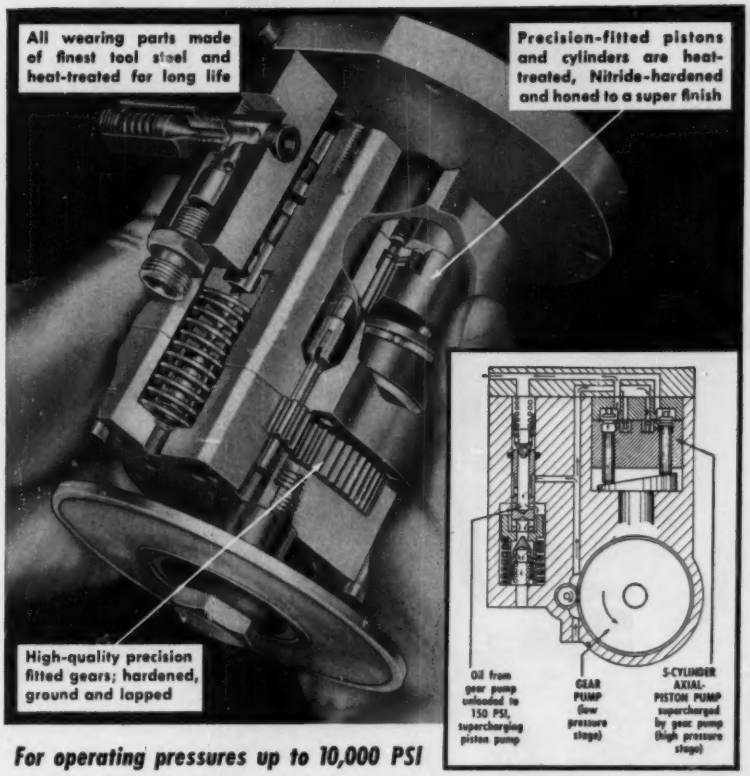
Circle 485 on Page 19

Drafting Unit

provides easy access from front of board

New Equipoise drafting machine incorporates a totally enclosed protractor, coupled with a magnifier lens that insures extremely accurate readings. Base-line setting lock provides fast, positive base-line settings. Magnifier rotates with the vernier through 360 deg, and settings to an accuracy of 1 min through the magnifier lens are accomplished. Equipoise mechanism has been redesigned and repositioned for easy access from the front of the board. A second Equipoise-type mechanism has been installed in the drafting elbow. Adjustment of these two units allows the board to be tilted up to 25 deg. Ball-joint arm linkage permits lifting of arms without disturbing machine alignment. Unit has touch-control method of angle selection. New leveling device permits mounting of the machine on




All wearing parts made of finest tool steel and heat-treated for long life
Precision-fitted pistons and cylinders are heat-treated, Nitride-hardened and honed to a super finish
High-quality precision fitted gears; hardened, ground and lapped
Oil from gear pump unloaded to 150 PSI, supercharging piston pump
GEAR PUMP (low pressure stage)
5-CYLINDER AXIAL-PISTON PUMP supercharged by gear pump (high pressure stage)

For operating pressures up to 10,000 PSI

New, unique 2-stage hi-pressure hydraulic pumping unit—dual-volume, dual-pressure

- **DELIVERS HIGH-VOLUME AT LOW PRESSURE**
- **2.6 GPM @ 100 PSI**
  1.75 GPM @ 500 PSI
  80 CU. IN./MIN. @ 1,000 PSI
  50 CU. IN./MIN. @ 10,000 PSI

The new and modern OTC "Vanguard" hi-lo hydraulic power package is a precision-built, high-quality unit meticulously crafted for dependable performance and long life. To best utilize the "Vanguard's" exceptional performance, a wide range of accessories are available: your choice of several motors, gasoline engine, 2 and 4-way lever-control valves, 2-way solenoid valve, pressure switch, pressure regulating valve, manifold, reservoirs, gauges, etc.

For detailed information on this advanced, new unit, write:

PRECISION HYDRAULICS DIVISION
OWATONNA TOOL CO.
712 CEDAR STREET OWATONNA, MINNESOTA

Circle 333 on Page 19

THE FREEDOM DIMENSION

. . . is shape flexibility

The investment casting process allows a new *freedom of design* . . . in shape . . . in materials. You can now design for function—the way you want the part!

This functionally designed instrument chassis was poured as an investment casting without design compromise. Dozens of expensive and complicated machining operations would otherwise have been required. Check your design with Hitchiner—in many cases you can buy *just what you want.*

Write for complete technical and facilities information.

HITCHINER
Milford 1, New Hampshire

Circle 334 on Page 19

boards of moderate warpage or surface irregularity. **Charles Bruning Co. Inc.**, 1800 W. Central Rd., Mount Prospect, Ill.

Circle 486 on Page 19

Tape Recorder

miniature unit resists 1000 g shock

Model MR-21 miniature magnetic tape recorder records up to 14 channels of data simultaneously on 1-in. magnetic tape. Total tape capacity is 69 feet. Unit operates through extreme environmental conditions, including up to 1000 g shock. Recording method allows operation with either ac or dc input signals, and power requirements are extremely low. Measuring only 4 in. diam by 3 in. long, recorder weighs less than 2 lb. It operates in temperatures from −65 to +165 F. **Borg-Warner Controls Div., Borg-Warner Corp.**, P. O. Box 1679, Santa Ana, Calif.

Circle 487 on Page 19

Character Generator

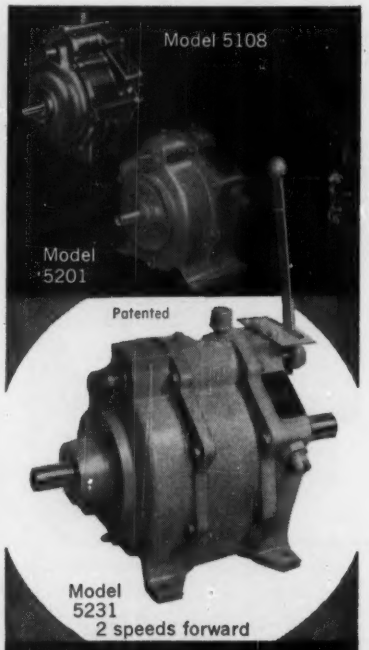
can be used with any cathode-ray-tube display

Curviline character generator combines continuous straight and curved lines to form digits, letters, and symbols on any cathode-ray-tube display at rates to 50,000 characters per sec in the standard unit. Rates to 200,000 characters per sec are available in special units. Fully transistorized unit requires no operating controls or adjustments. Series C36000 is packaged in a 4 x 6 x 7-in. cabinet for use where space is at a premium. Series CL 36000 is available on a standard 5¼-in. relay rack panel for use as a computer or laboratory module. **RMS Associates Inc.**, 805 Mamaroneck Ave., Mamaroneck, N. Y.

Circle 488 on Page 19

S-N REVERSING TRANSMISSIONS

5 models 8 and 28 h.p. with power packed versatility



S-N Reversing Transmissions are performance proven, space-saving single units which reverse under full load. Adaptable to the design or redesign of a wide variety of industrial equipment. For technical data write The Snow-Nabstedt Gear Corp., Hamden, Conn.

SPECIFICATIONS

Model No.		5231	5201	5108
Reduction Forward		1.97:1 3.34:1	3.16:1	3.75:1
Ratio Reverse		3.37:1	3.16:1	3.75:1
Power Up To		28 HP	28 HP	8 HP
Max. Input Torque in. lbs.		1000	1000	320
Max. Input Speed RPM		2400	2400	2400
Dimensions	Long	15 1/16"	11½"	9 1/16"
	Wide	14"	13½"	10"
	High	14¾"	14¼"	10⅝"

SNOW-NABSTEDT
Industrial Division
Transmission Engineers
For Over Half a Century

Circle 335 on Page 19

THE ENGINEER'S

Library

Recent Books

Miniaturization. *Edited by H. D. Gilbert; 306 pages, 6 by 9 in., clothbound; published by Reinhold Publishing Corp., 430 Park Avenue, New York 22, N. Y.; available from* MACHINE DESIGN, *$10.00 postpaid.*

This book presents a complete rundown of problems encountered in design, maintenance, and assurance of reliability of miniature devices, and describes how best to meet these problems. Sixteen experts in their particular fields cover miniaturization in missiles, satellites, medicine, computers, aircraft electronics equipment, communications equipment, military equipment, consumer products, and special requirements of miniaturization for space travel.

Transistors and Active Circuits. *By John G. Linvill and James F. Gibbons; 515 pages, 6 by 9 in., clothbound; published by McGraw-Hill Book Co. Inc., 330 West 42nd St., New York 36, N. Y.; available from* MACHINE DESIGN, *$14.50 postpaid.*

This book discusses fundamental problems in active circuits, particularly those in which the active element is a transistor. The model concept is stressed throughout; in particular, the approximate characters of models and the assumptions involved in their use. Emphasis is placed on the selection of the most appropriate model according to the requirements of the particular problem.

Frequency Modulation Theory. *By Jacques Fagat and Philippe Magne; 488 pages, 6 by 9 in., clothbound; published by Pergamon Press, Headington Hill Hall, Oxford, England; available from* MACHINE DESIGN, *$15.00 postpaid.*

This book is divided into five parts, the first part describing meter, decimeter, and centimeter-wave propagation. Frequency curves and results are given for optical paths and transmissions beyond the horizon. The second part discusses

WIDE GRIP RANGE

Wide grip range lets you use just one rivet length for thick or thin work sections. For example, a No. 610 "POP" Rivet has a grip range of nearly 5/3" and can be used for work from .020" to .065" in thickness! This simplifies your fastener specification problems . . . and greatly reduces your inventories. Ordering greater volume per size, you'll secure the lowest possible rivet price. You'll eliminate a source of operator error, because "POP" Rivets don't depend on close matching of rivet length to work thickness for high fastening quality. And this same non-critical length factor also makes "POP" the ideal fastening for thin materials; even .020" soft aluminum can be fastened securely without stripping!

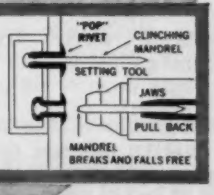
If you want to improve the quality, appearance and sales appeal of your products . . . and cut fastening costs at the same time . . . be sure to investigate all of the reasons why "POP" Rivets run rings around the rest! Write today for complete information . . . and for the name of your local "POP" Rivet Distributor.

Genuine "POP" Rivets Are Available Through a Large Network of Distributors Throughout The Country.

UNITED "POP" RIVETS

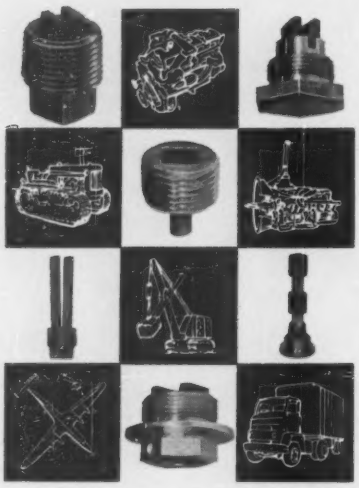
HERE'S HOW THEY WORK

"POP" Rivets are inserted and set from the same side: (1) Rivet is inserted in the work. (2) Jaws of the easy-to-use setting tool grasp the mandrel. (3) Tool is operated. Jaws pull back. Rivet is set. Mandrel breaks and falls free.



FASTENER DIVISION • UNITED SHOE MACHINERY CORPORATION
1924 River Road, Shelton, Connecticut, U.S.A.

WORTH TESTING IN YOUR PRODUCT



LISLE *Magnetic* PLUGS

If your product has moving parts operating in a fluid, a test will prove that you can reduce costly wear with Lisle Magnetic Plugs.

Ferrous metal particles in a lubricant are a major cause of wear. The Lisle Magnetic Plug removes these abrasive particles — eliminates unnecessary wear.

See for yourself. Try Lisle Magnetic Plugs in place of the ordinary drain or fill plug in your product.

FREE *Samples for Testing in Your Product!*

LISLE CORPORATION
Clarinda, Iowa

Circle 337 on Page 19

all the fundamental concepts of frequency-modulated systems ending with a thorough examination of the signal-to-noise ratio. The problems of distortion in connection with propagation phenomena are examined in the third part and a synthesis of all the proceeding concepts is given in the fourth. The fifth part deals with the problems of apparatus.

Optimum Use of Engineering Talent. *Edited by Jerome W. Blood;* 416 *pages,* 6 *by* 9¼ *in., clothbound; published by American Management Association,* 1515 *Broadway, Times Square, New York* 36, *N. Y.,* $9.00 *postpaid* (*AMA members*: $6.00).

This comprehensive analysis of engineering management in industry covers the experience of 31 executives and specialists in appraising management-engineer relationships which could improve engineering effectiveness. Case studies of operating procedures in major corporation engineering staffs are included. Representatives of leading companies discuss every phase of effective engineering management—from basic objectives, responsibilities, and organization of the engineering division to recruiting and selection, compensation, supervision, professional development, and evaluation.

Government Publications

OTS Technical Reports. Copies of reports listed below are available from Office of Technical Services, U. S. Dept. of Commerce, Washington 25, D. C.

TN D-823. Tensile Properties of 17-7 PH and 12 MoV Stainless Steel Sheet Under Rapid-Heating and Constant-Temperature Conditions. By Charles R. Manning Jr. and Howard L. Price, Langley Research Center; 28 pages, 8 by 10½ in., paperbound, stapled; **$0.75 per copy.**

Results of rapid heating tests are presented on 17-7 PH and 12 MoV stainless steel sheet heated to failure under constant load conditions. Yield and rupture strengths obtained from rapid-heating tests are compared with yield and tensile strengths obtained from short-time elevated-temperature tensile tests (30 minute exposure). A rate-temperature parameter was used to construct master curves from which yield and rupture stresses or temperatures can be predicted.

TN D-668. Polyester Film Belts. By John H. Licht and Arthur White, Goddard Space Flight Center; 18 pages, 8 by 10½ in., paperbound, stapled; **$0.50 per copy.**

Fatigue resistance, high-stress tolerance, uniformity, and ability to be driven by extremely small pulleys are some of the many properties which make polyester film belts superior for use in a number of applications. This paper indicates performance based on a limited number of tests, suggests design criteria, and describes fabrication procedure, applications and characteristics.

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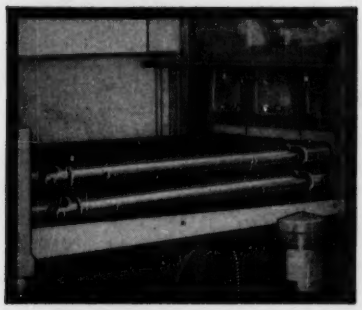

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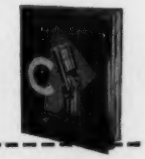

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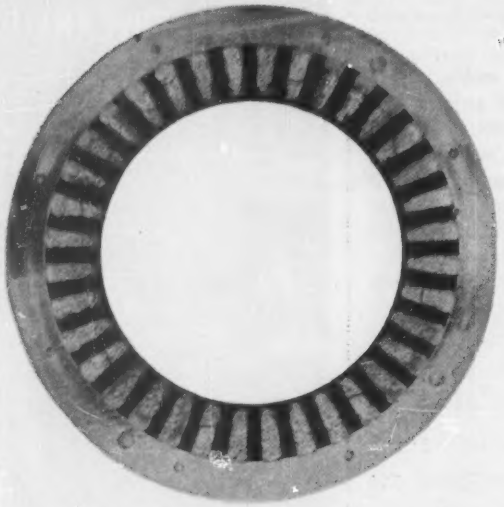

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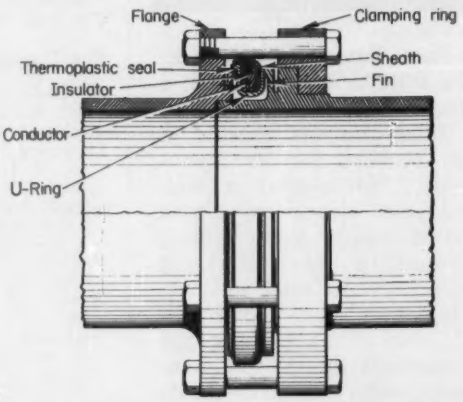
Patents

Thermoplastic Pipe-Joint Seal

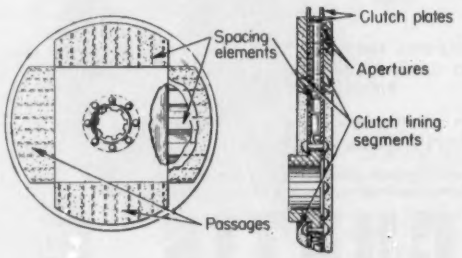
In a pipe joint, a thermoplastic seal is fused between a fin and U-ring by establishing a heat circuit within the ring. The annular thermoplastic strip is assembled between the left fin and overhanging flange of the U-ring. The clamping ring and bolts are then assembled to compress the strip. When the parts are



in position, the two heating wires are connected to an external source of electric current to fuze the strip between the fin and U-ring confronting surfaces. To break the joint, the bolts are removed and current is again supplied to the wires long enough to soften the seal formed by the plastic strip. *Patent* 2,992,838 *assigned to United Aircraft Corp., East Hartford, Conn., by Rudolph N. Wallace.*

Air-Cooled Clutch

Segmented friction surfaces mounted back to back on a double-faced clutch are separated by corrugated sheet-metal spacers to permit maximum air flow for



continuous cooling action. The friction elements are fastened on the clutch plate surfaces so that each segment is axially aligned with a spacer. Apertures are formed in the plates to facilitate heat transfer from

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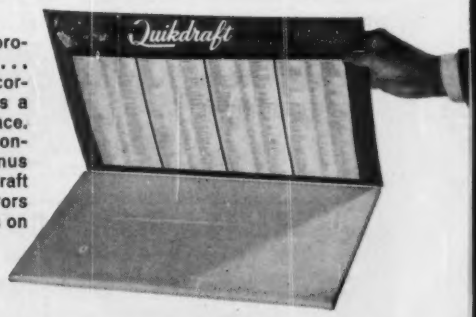

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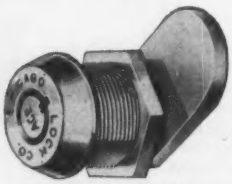

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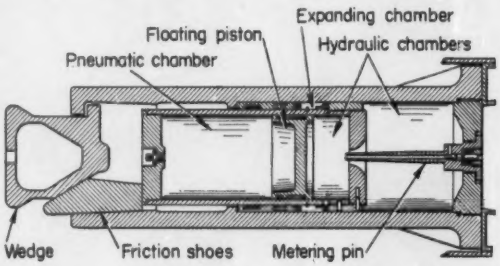
the friction segments to the air circulating through the inner passages as the clutch member rotates. *Patent 2,994,419 assigned to International Harvester Co., New Jersey, by Paul T. Brantingham.*

Heavy Duty Shock Absorber

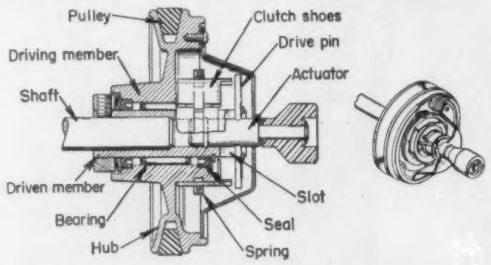
A cushioning device combines a friction brake with a pneumatic-hydraulic cylinder to absorb kinetic energy of shock or pulling loads. Under axial loading, the base remains stationary and a wedge member is forced to the right, driving friction shoes in the same direction. Hydraulic resistance, which is controlled by a metering pin, builds up under friction shoe movement to the right. This resisting force increases wedging



force on the shoes. Heat generated at the friction surfaces dissipates 25 to 40 per cent of the kinetic energy. Constant frictional force is maintained throughout the remainder of the cushioning stroke. Excess kinetic energy is stored in the pneumatic chamber by a floating piston which compresses the air charge. The compressed air returns the cushioning device to its original position when the applied loads are released. *Patent 2,994,442 assigned to The Bendix Corp., South Bend, Ind., by George E. Frederick.*

Slip-Type Dog Clutch

Engagement shock is minimized in a dog clutch by spring-loaded clutch shoes. Stamped shoes are held in contact with the OD of the driving member hub by spring-action snap rings to permit shoe slippage. Shoes are keyed against axial movement relative to

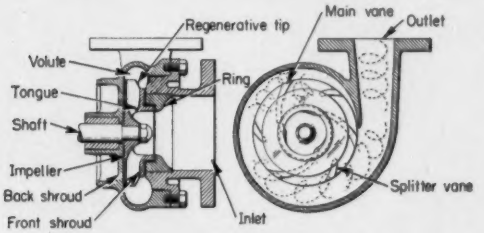


the hub. Jaws clamp drive pin when actuator is moved to the left. At the same time, the drive pin engages a slot in the driven member. The drive pin is made of spring material to allow flexing on engagement, thus supplementing shock-absorbing action of

shoes which slip until running speed is attained. A detent spring on the OD of the actuator locks it in the engaged position. *Patent 2,988,187 assigned to Jabsco Pump Co., Costa Mesa, Calif., by Warren Doble.*

Continuous-Priming Centrifugal Pump

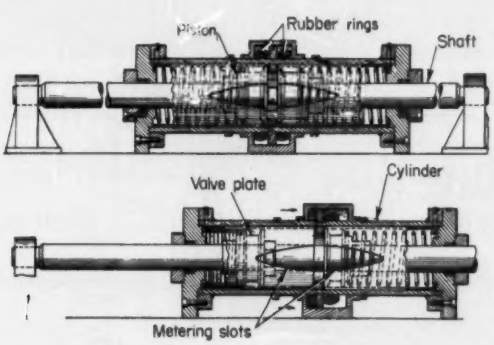
Pump moves a mixture of liquids, gases and/or solids with continuous-priming action by returning heavier liquid layers through a slotted lip between discharge outlet and impeller outer surfaces. A slotted tongue



in the inlet pressurizing passage imparts a helical motion to the fluid as it enters the vanes of the impeller. Regenerative vane tips and a circular volute section combine to redirect centrifugal component of fluid pattern for shockless return flow. This flow action moves the lighter substances to the center of flow and carries them out of the volute to the discharge outlet. *Patent 2,992,617 assigned to Worthington Corp., Harrison, N. J., by Henry H. Kroeger.*

Double-Acting Shock Absorber

Shock absorber uses moving cylinder with split, moving piston to dissipate energy of shock loads in either direction of shaft movement. Tapered metering slots in two internal wall sleeves produce progressive fluid throttling action for smooth cylinder deceleration. Flow of hydraulic fluid under load and



during return stroke is controlled by valves in plates at inboard end of each piston. Resilient elliptical rings provide reserve stopping power at the end of piston stroke. Return springs restore the parts to their original position when load is released. An accumulator is not required since piston rod movement does not

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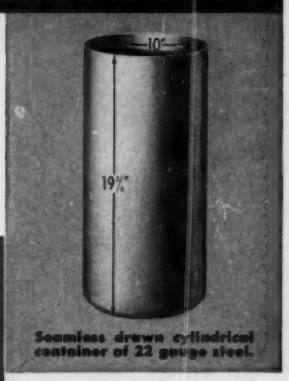
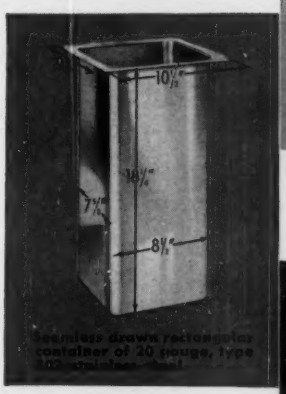


Seamless drawn cylindrical container of 22 gauge steel.



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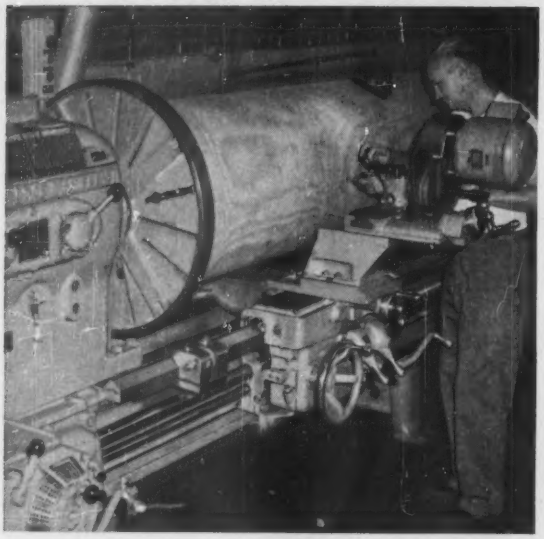

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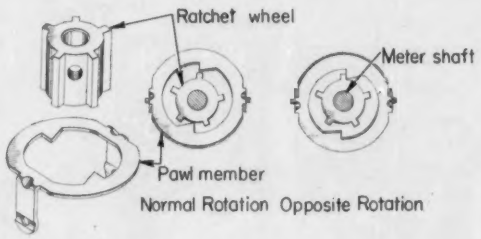
change the net fluid volume. *Patent* 2,992,815 *assigned to Hanna Engineering Works, Chicago, Ill., by John T. Ellis, Jr.*

One-Way Shaft Brake

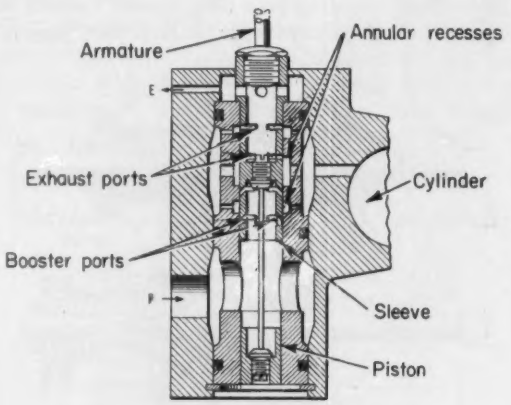
Ratchet-wheel and pawl assembly acts as one-way brake to prevent reverse shaft rotation. The ratchet wheel is mounted at the end of the shaft. It consists of a sleeve with five equally spaced external teeth. The pawl is a stamped ring with two internal teeth spaced



180 deg apart. Two side tabs on the pawl are pinned to a collar to provide pivot mounting. The triangular pawl teeth oscillate about the pivot point to permit free ratchet-wheel rotation in one direction but block reverse rotation within one-tenth of a revolution of the shaft. *Patent* 2,994,412 *assigned to General Electric Co., New York, by Donald M. Smith and Victor E. Sodergren.*

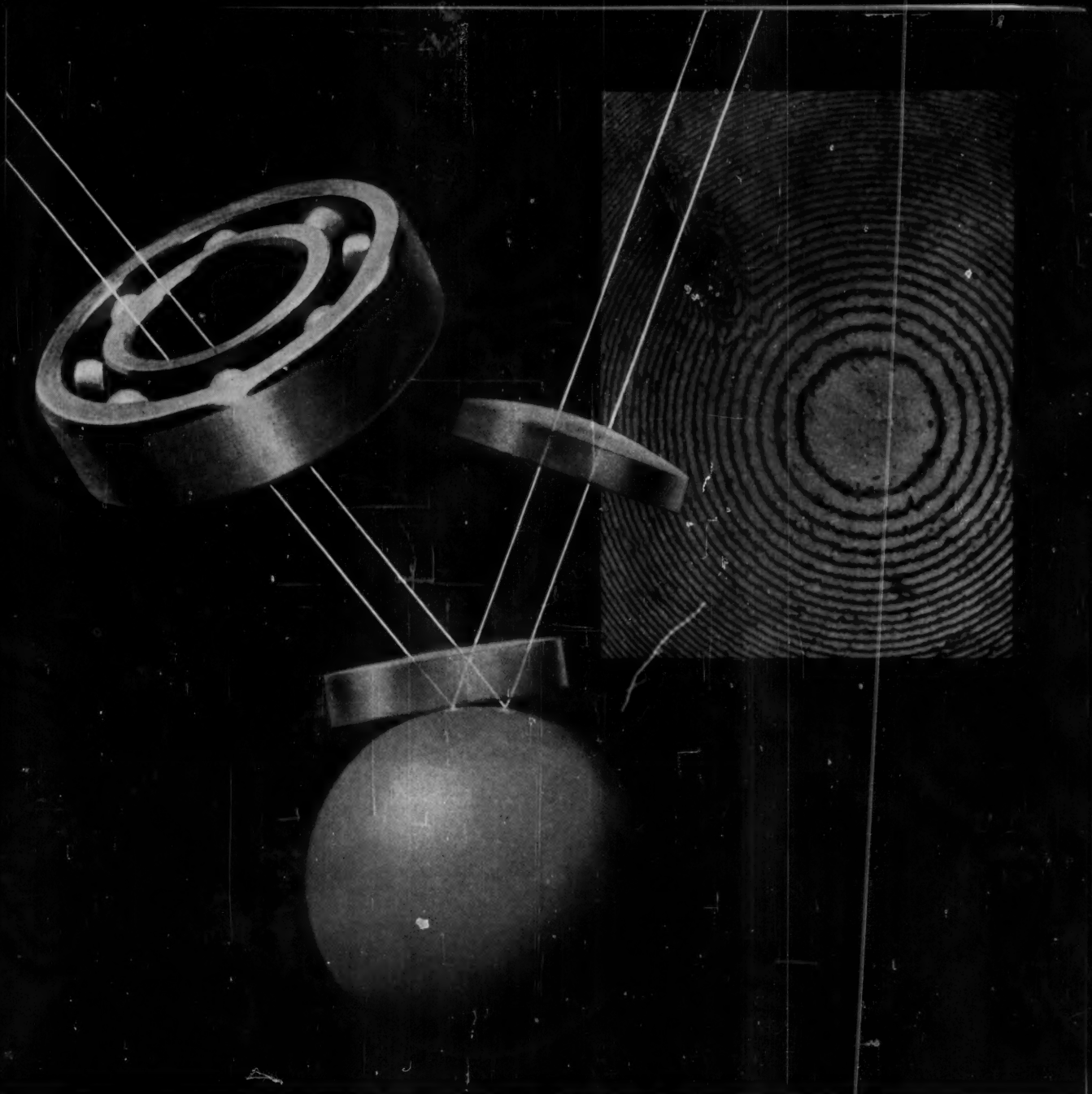
Jet-Assisted Sleeve Valve

Valve uses angled booster ports in sleeve wall to assist valve closing action. Sleeve moves downward to exhaust fluid from cylinder through exhaust ports when solenoid



is energized to actuate armature at top of sleeve. On release of solenoid, difference in diameters between sleeve and piston causes sleeve to move upward under pressure P. Jet reaction force of fluid passing through booster ports assists this action. This design allows

Circle 345 on Page 19



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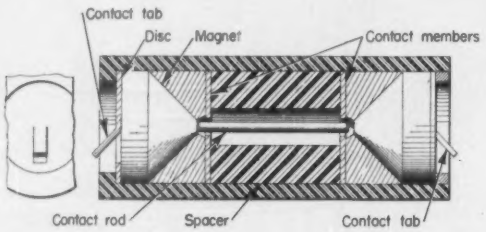
Circle 346 on Page 19

use of small, fast-acting solenoid without losing speed in sleeve return movement. *Patent* 2,996,078 *assigned to International Business Machines Corp., New York, by Marshall E. Freeman and James C. Gilmore.*

Magnetic Tremble Switch

A high-permeability contact rod, floating in a flux field between two magnets, closes a switch circuit when vibrated at resonant frequency. The magnetic field holds the rod in the center of holes in two annular contact members. The rod normally contacts a



magnet on one end. When external vibration creates a resonance condition at the rod, the end not in contact with a magnet moves to engage the adjacent contact member, thus closing the circuit. Natural frequency of the rod is a function of rod and magnet design and position. By varying these factors, the switch-actuating frequency may be readily changed. *Patent* 2,996,586 *assigned to United States of America as represented by the Secretary of the Navy by Maurice E. Shindledecker, Edward F. Branagan and Charles S. Horsman.*

Recirculating-ball nut for miniature ball-bearing screw assemblies uses wire elements as ball deflectors. Three coiled wire sections with machined ends are equally spaced along the length of the nut and brazed in place in the nut threads. The wires deflect balls into two transfer tubes which are soft soldered to an external rib in the nut wall. Tubes return the balls for recirculation in the assembly. *Patent* 2,995,948 *assigned to General Motors Corp., Detroit, Mich., by David A. Galonska and William T. Gobble.*

Removable Teflon plug-valve inserts permit handling of corrosive fluids. The proportions of plug, body, and liner are such that all throttling action by the plug occurs between the downstream side of the plug and the outlet port of the body. Various insert forms are adapted for different modes of operation and for modification of existing valves. *Patent* 2,987,295 *assigned to The Duriron Co. Inc., Dayton, Ohio, by Robert C. Schenck and Jacob B. Freed.*

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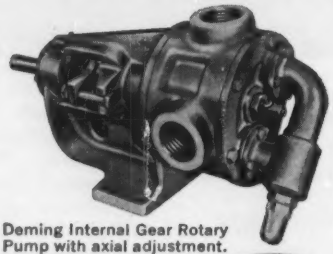

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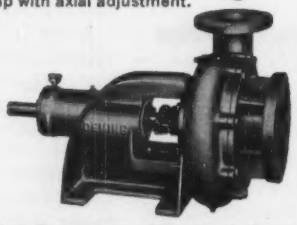

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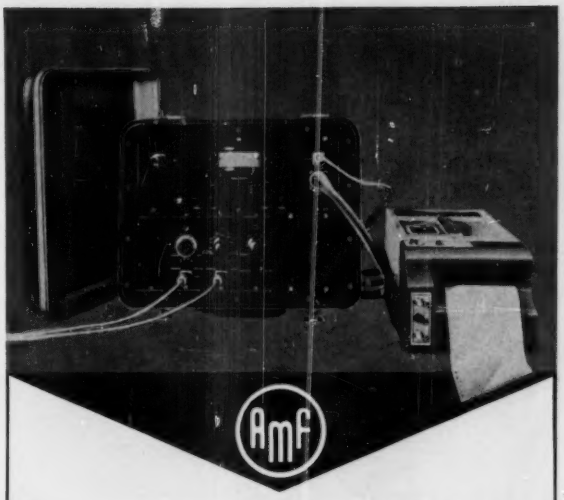

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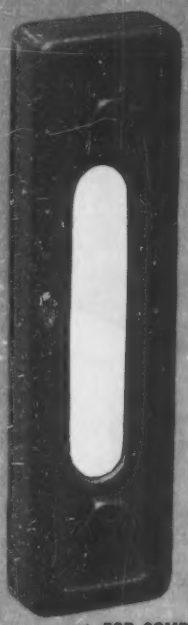

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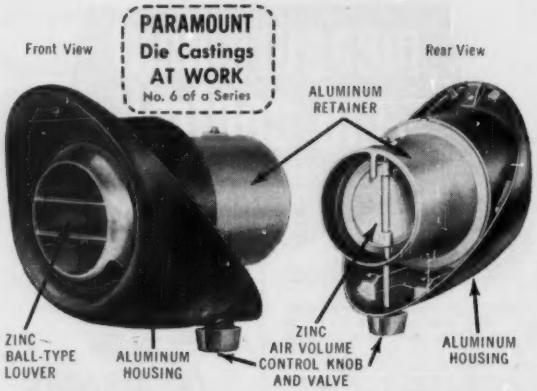

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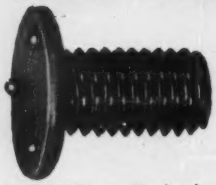

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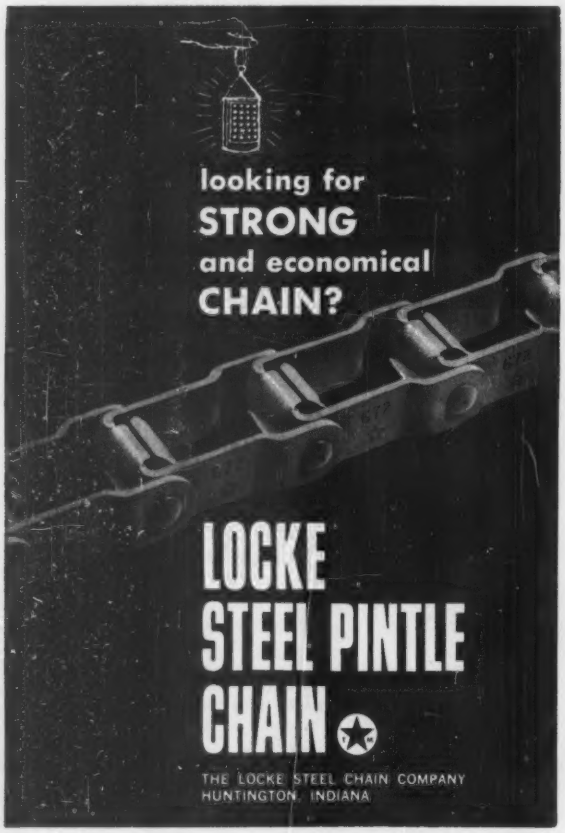

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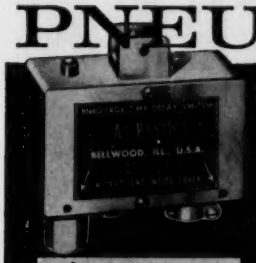

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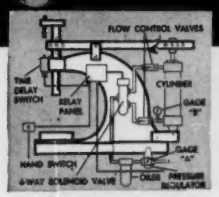
FOR CONTROLLED TIME DWELL OF AIR OR HYDRAULIC CYLINDERS



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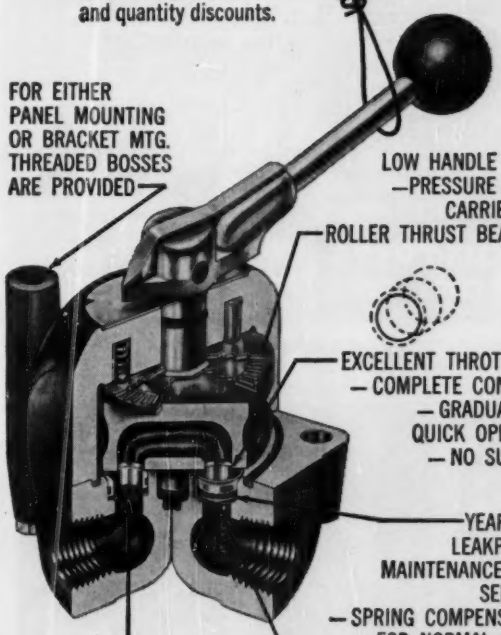

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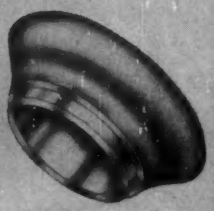

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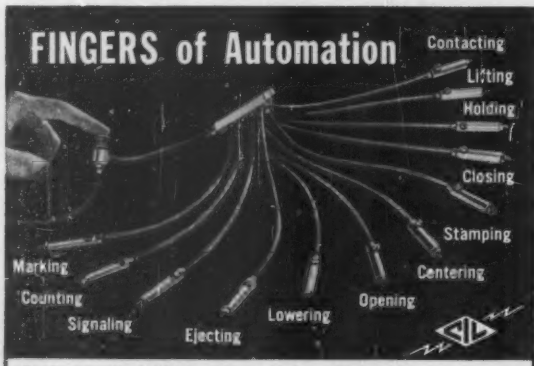

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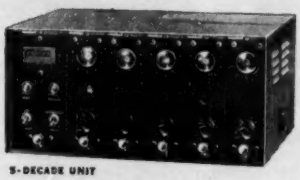
improve accuracy, cut costs with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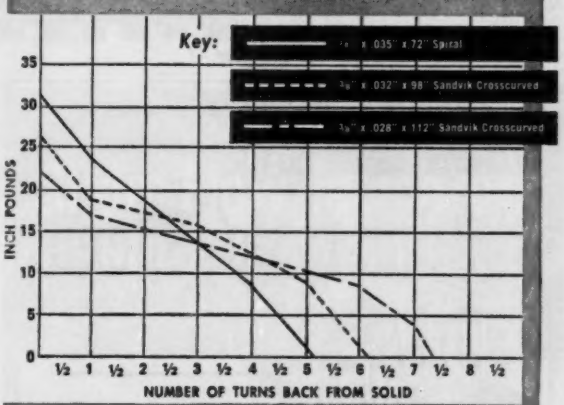

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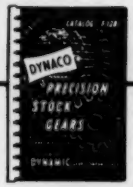

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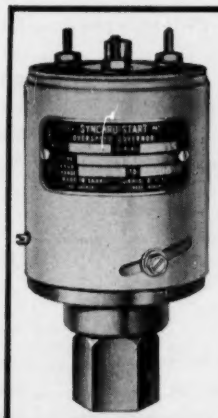

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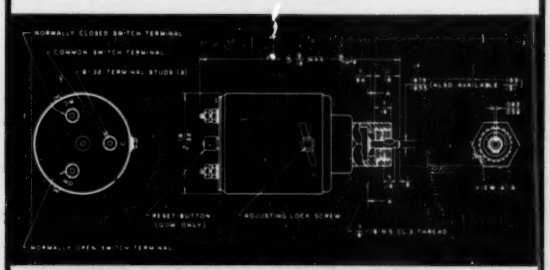

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MACHINE DESIGN is sent at no cost to management, design and engineering personnel whose work involves design engineering of machines, appliances, electrical and mechanical equipment, in U. S. and Canadian companies employing 20 or more people. Copies are sent on the basis of one for each group of four or five readers. Consulting and industrial engineering firms, research institutions and U. S. government installations, performing design engineering of products are also eligible.

Subscription in United States, possessions, and Canada for home-addressed copies and copies not qualified under above rules: One year, $10. Single copies $1.00. Other countries: One year, $25. Published every other Thursday by The Penton Publishing Co., Penton Bldg., Cleveland 13, Ohio. Accepted as Controlled Circulation publication at Cleveland, Ohio.

BPA NBP

backtalk——

—Chief Cook

Everybody knows that too many cooks spoil the broth, and that's why we have only one. He is known officially as Stanley G. Cook, Assistant Editor, MACHINE DESIGN, and he edits

the electrical articles which we publish. Well versed in ac and dc, our SC earned a degree in electrical engineering at Purdue University, then served as project engineer on dc generators at Jack & Heintz, Cleveland, before joining our staff in 1958. While in college, he wrote for a newspaper published for the electrical engineering students.

When Stan switches from work to play, he enjoys a brisk chess game. As befits a man of Stan's taciturnity, another of his hobbies is listening. He is a hi-fi-phile, favoring nonoperatic classical and melodious popular music. He finds that music-listening is not a spectator sport and is constantly tinkering with the equipment, adding new speakers, replacing components, etc. He is even moving into a larger house to make more room for records, equipment, and sound.

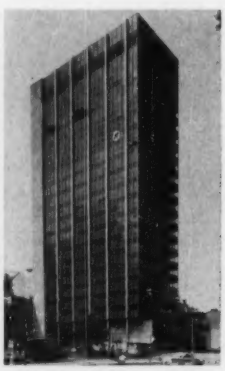
—Current Electrical Coverage

Some of Stan's editing handiwork — and J. Ronald Wickey's writing — is on Page 150. This article concludes the series, "DC Motor Control," all six parts of which will be reprinted and sold for one dollar. Copies can be ordered (so can copies of Messrs. Wickey and Newman's previous series, "AC Motor Control") from Reader Service, MACHINE DESIGN, Penton Bldg., Cleveland 13, Ohio.

—It's a Blue World . . .

The earth, viewed from the moon, will probably appear bluer than the moon looks from earth, say Aerojet-General scientists. Furthermore, the bluish "earthglow" will be enhanced by fluffy cloud formations and a view of the polar ice caps. These will be visible because the earth is much more reflective than the moon. Looking at the earth from the moon, instead of the other way around, should be more rewarding to romanticists and the lunar equivalent of baying hounds, because a full earth will be on view (to those on the "warm" side of the moon) for ten of the 28 days it takes to circle the earth.

—Society Note



The first of this month, 50-year occupants of the Engineering Societies Bldg. on West 39th St., along with several additional organizations, moved into one of New York City's newest buildings, the United Engineering Center. The building, located at 345 East 47th St.—across the street from the United Nations—is an imposing 20 stories of stainless steel, glass, limestone, and granite. Occupants include the five "founder societies"—American Society of Mechanical Engineers; American Institute of Electrical Engineers; American Institute of Mining, Metallurgical, and Petroleum Engineers; American Society of Civil Engineers; and American Institute of Chemical Engineers—and 16 other groups. Total membership represented exceeds 300,000.

Besides claiming the largest concentration of professional engineering societies in the Free World, this building houses the largest free public engineering library in the Free World. Capacity of the Engineering Societies Library is 250,000 books.

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One article tells how MoS_2 prevents harmful friction in brake linings. Another discusses its use as a compressor lube substitute. Still another reports on tests of epoxy-resin compositions containing high concentrations of MoS_2 for industrial use on bearings, seals and friction strips.

Press fittings, wire drawing, cutting tools, ball joints—there are MoS_2 stories about these uses, too.

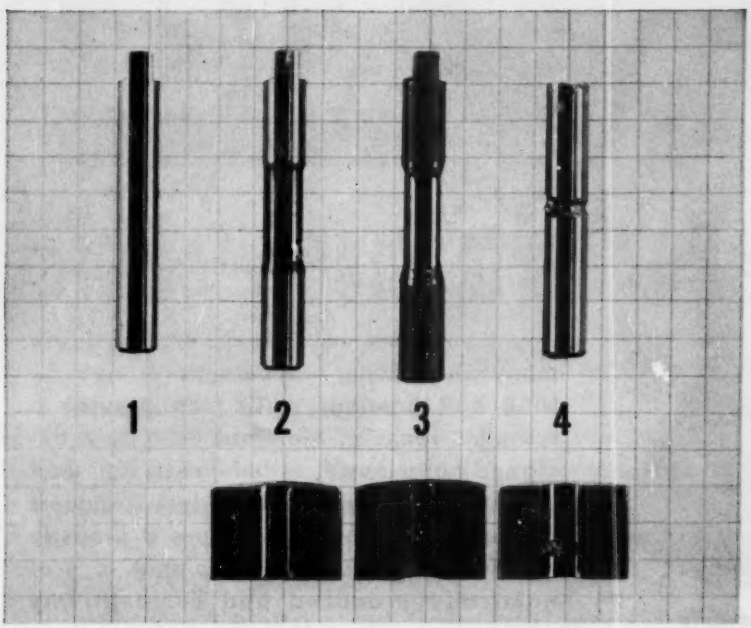
MoS_2 as a solid-film dry lubricant has been the subject of several articles. One details high-temperature properties; another describes a new bearing design that can increase bearing life as much as 450%.

Write us for a complete bibliography of published material on molybdenum disulphide.

P.S. Climax publishes a newsletter that describes even more uses. Let us know if you'd like your name on the mailing list.

When writing, refer to CL-113

Proof of MoS_2's High-Pressure Properties



Photograph above shows mild steel test pins. No. 1: Unused pin, No. 2 (lubricated with mineral oil and Molysulfide) and No. 3 (with Molysulfide bonded coating) were subjected to rotating pressures between bearing halves. Both were elongated and extruded without galling, seizing, or weight loss. No. 4 shows typical failure with conventional lubricant. Note that the key sheared off and pin and block were galled and seized.

When writing, refer to CL-115

ASME SHOW DEVOTES SESSION TO "MOLY" LUBES

New evidence of mounting interest in molybdenum disulphide was shown recently among members of the American Society of Mechanical Engineers. A spokesman for the Climax Chemical Division was invited to speak on "Molybdenum Disulphide as a Lubricant" before the Machine Design Division at the 1961 Design Engineering Conference. A copy of this 24-page paper is available on request.

At the same meeting, engineers from Socony Mobil Oil Company spoke on "Molybdenum Disulphide as an Additive to Improve the Performance of an Automotive Multi-purpose Grease." Write to Climax for a copy of this paper.

When writing, refer to CL-114

[redacted] Sees Increased Sales, Lower Profits
Its midyear report confirms [redacted] Company's prediction for the current fiscal year. Despite increased sales volume, profits have been substantially lower than expected.
Rising Costs Cut Profits, [redacted] Reports
[redacted] Company's 1st half operations showed a drop in profits, according to the Company's president. Increases in the cost of several basic manufacturing items accounted for a good portion of this tapering of profits.
[redacted] Reports 2nd Quarter Drop
[redacted] Manufacturing reports its 2nd quarter showed a drop in net profits. A spokesman reported that this condition arose despite slight increase in sales.
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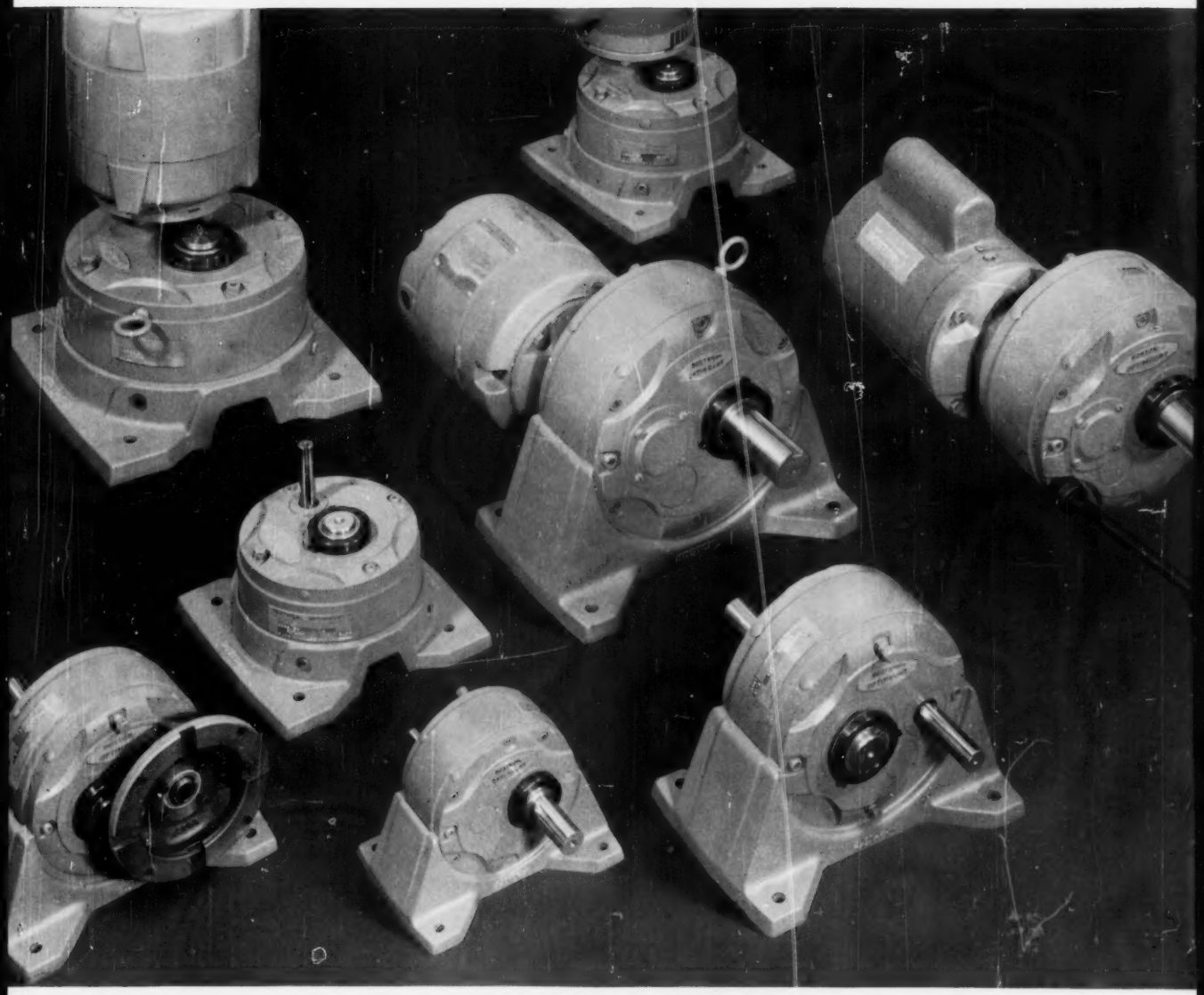

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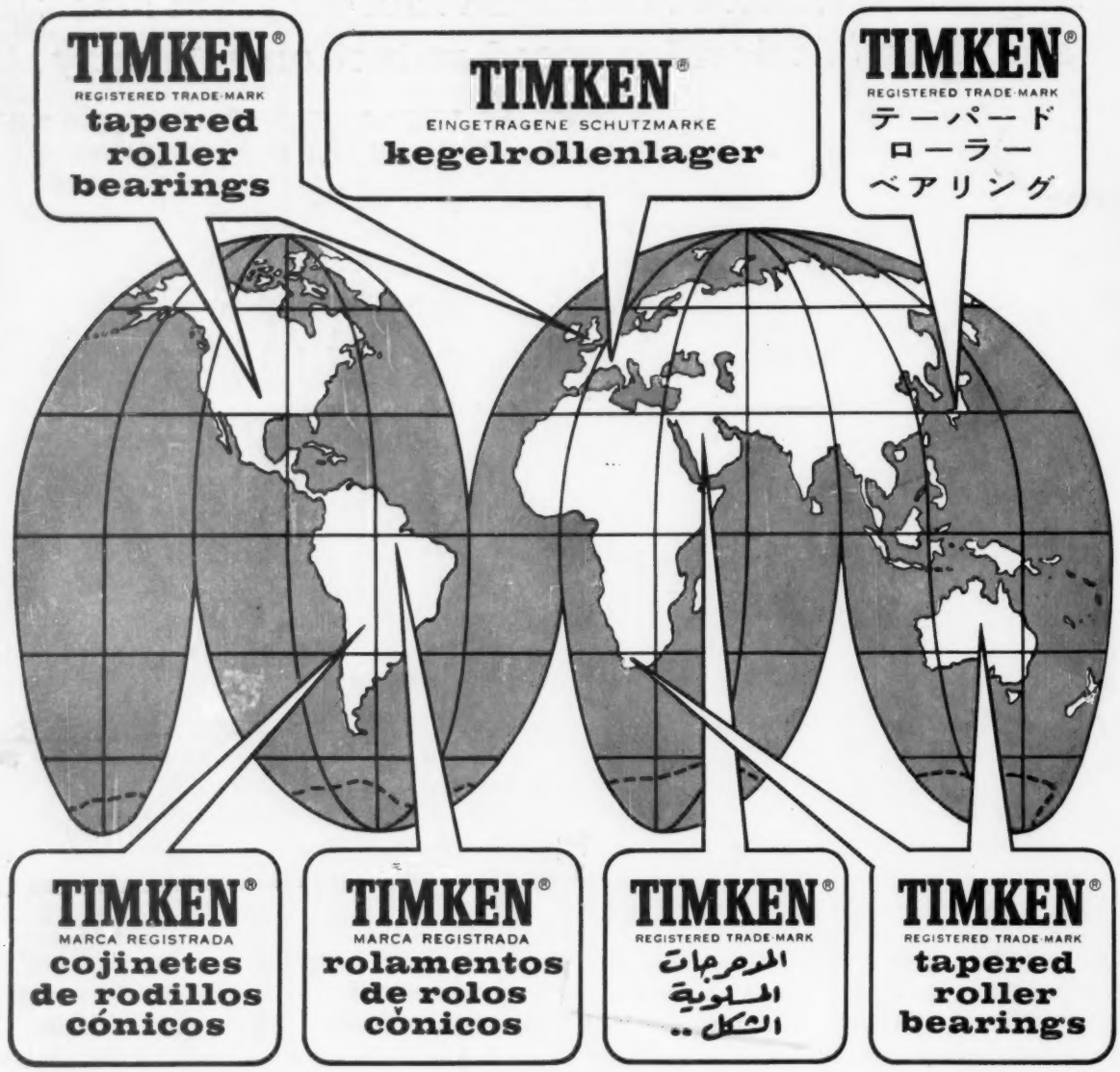

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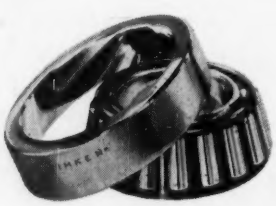

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